AMEREN MISSOURI LABADIE ENERGY CENTER

LABADIE SULFUR REDUCTION PROJECT

QUALITY ASSURANCE PROJECT PLAN

Prepared For:
AMEREN CORPORATION
Ameren Missouri Labadie Energy Center
226 Labadie Power Plant Road
Labadie, MO 63055

Prepared By:
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Submitted to
Missouri Department of Natural Resources
Air Pollution Control Program
P.O. Box 176
Jefferson City, Missouri 65102-0176

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DISTRIBUTION LIST

Table A1 provides the names, professional titles, organizations, and contact information for the individuals involved in the development of this Quality Assurance Project Plan (QAPP). This list will be used to distribute all QAPP updates.

Table A1: QAPP Distribution List

Key Individuals and Affiliations	Contact Information
Patricia Maliro* Air Monitoring Unit Chief Air Pollution Control Program Missouri Department of Natural Resources	1659 East Elm Street Jefferson City, MO 65101 573-751-4817 Patricia.maliro@dnr.mo.gov
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Thomas Ferrebee Quality Assurance Coordinator Enviroplan Consulting LLC	155 Route 46 West, Suite 109 Wayne, NJ 07470 973-575-2555 tferre3@bellsouth.net
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TBD* Field Operator(s) Enviroplan Consulting LLC	TBD (Vicinity of Labadie, MO)

*Three copies of the QAPP and all instrument SOPs to be distributed to MDNR. One copy of the QAPP and all instrument SOPs and Operator Manuals to be maintained at each monitoring site.

APPROVALS

Patricia Maliro Air Monitoring Unit Chief Air Pollution Control Program Missouri Department of Natural Resources	Date
Robert Laplaca Project Manager Ameren Services	Date
Kenneth Anderson Manager, Air Quality, Environmental Services Ameren Services	Date
David Cummings Program Manager Enviroplan Consulting LLC	Date
Thomas Ferrebee III Quality Assurance Officer Enviroplan Consulting LLC	Date

SECTION A: PROJECT MANAGEMENT ELEMENTS

A1. PROJECT/TASK ORGANIZATION

Ameren Corporation (Ameren) operates the Ameren Missouri Labadie Energy Center (Labadie Energy Center), a coal-fired electric power generating station located at 226 Labadie Power Plant Road in Franklin, County, MO. To better assess ambient air concentrations of sulfur dioxide (SO_2) with respect to the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS), Ameren plans to implement an ambient air quality and meteorological monitoring program in the vicinity of the Labadie Energy Center. The duration of the monitoring program is anticipated to be to be three years, however, this period will be re-evaluated on an annual basis.

The anticipated application of the monitoring data is to assess compliance with the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The fully quality-assured, validated monitoring data will be reported to the Missouri Department of Natural Resources Air Pollution Control Program (MDNR APCP).

As the operator of the Labadie Energy Center, Ameren is the organization responsible for implementation of the Labadie Sulfur Reduction Project and consequently will be the overall project manager. In order to facilitate technical decisions regarding sites, site locations, Quality Assurance/Quality Control (QA/QC) procedures, methods, data reporting, etc., Ameren has elected to retain the services of Enviroplan Consulting for operations and maintenance, advice, support services and other activities necessary to implement the monitoring program in accordance with an approved QAPP.

Since 1974, Enviroplan Consulting has specialized in the measurement and study of air pollution and meteorology. Our experience includes conducting over 100 ambient air quality and meteorological monitoring programs and numerous modeling studies to assist our clientele in addressing air permitting issues and meeting regulatory requirements.

A.1.1 Key Personnel / Areas of Responsibility

The personnel considered key to the successful operation of the monitoring program are listed in Table A2. Figure A1 presents an organizational chart, including lines of responsibility and authority, for the Labadie Sulfur Reduction Project. The organization chart can be found in Appendix 1. The key Enviroplan Consulting project personnel will comprise the senior staff assigned to the project. A brief description of each person's major responsibilities follows.

The Enviroplan Consulting Management Plan for the Project is designed to satisfy all project requirements regarding quality and on-schedule performance. Clear lines of authority, adequate allocation of resources, expertise in planning and implementation are backed by years of successful ambient air quality monitoring and quality assurance audit experience represented by the Enviroplan Consulting project team. Enviroplan Consulting places special emphasis on maintaining strong management controls in the operation of its monitoring networks

Mr. Howard Ellis will be Senior Reviewer. His specific responsibilities for the project will include:

- Ensure the availability of adequate resources for performing the project in accordance with the requirements stated in the QAPP;

- Develop benchmarks and standards for measuring project progress and performance;

- Review and approve logistical planning and schedules for performing the work;

- On a monthly basis, or more frequently as-needed, meet with the Enviroplan Consulting Project Manager to review project status reports with respect to schedules and performance benchmarks; and

- Provide administrative support for the project.

Mr. David Cummings will be Project Manager. His specific responsibilities for the project will include:

- Mobilize personnel and equipment for the project, including acquisition of any standards or equipment needed for the project and ensuring all standards and equipment used have current, documented, NIST-traceable calibration and certification;

- Liaisons with Ameren regarding effective protocols for communications and information-sharing between Enviroplan Consulting project team members and surrounding communities and to ensure maximum responsiveness and coordination with stakeholders throughout the course of the project;

- Develop and revise as-needed schedules in consultation with Ameren; and

- Ensure the availability of alternate field personnel to conduct the scope of works on an emergency basis.

Mr. Thomas Ferrebee will be the Quality Assurance Coordinator. Mr. Ferrebee's specific responsibilities will include:

- Maintaining audit standards and equipment and NIST-traceability for all audit standards and equipment;

- Ensuring prompt safe delivery, local transport, custody and storage of calibration standards and equipment; and

- Prompt transmittal of audit status and completion information to the Enviroplan Consulting senior reviewer and designated Enviroplan Consulting personnel. The transmittal will clearly indicate marginally acceptable or unacceptable audit results so that corrective actions can be promptly initiated.

Ms. Kathy Stanwood will be the Data Manager. Ms. Stanwood's specific responsibilities will include:

- Ensure the review and evaluation of the prior day's raw digital data each business day and notify appropriate program personnel for resolution of any problems;

- Ensure the proper reduction, processing, validation and reporting of all network data in accordance with the procedures outlined in the approved QAPP; and

- Ensure all network data and data-related documentation are securely archived.

Mr. Kevin Ruggiero will be the Field Operations Manager. Mr. Ruggiero's specific responsibilities will include:

- Ensure appropriate stocks of spare parts and consumables are maintained in the network and replenished as necessary to ensure ready availability;

- Provide technical guidance and supervision to network operators on a routine and emergency basis to ensure all monitoring activities, investigative and corrective actions are performed in accordance with the SOPs and QAPP; and

- Expedite emergency replacements parts and/or equipment delivery to the network operator on an as-needed basis.

Field Operator's (to be determined) specific responsibilities will include:

- Conduct routine operations and maintenance of the network;

- Maintain the overall integrity of the sampling sites and reporting associated information; and

- Conduct proper sample collection, quarterly preventative maintenance, field calibration, field QA/QC activities and associated documentation.

The network field operator will be fully trained by Enviroplan Consulting in the proper operation, maintenance and requisite QA/QC checks and calibration methods for the monitoring equipment which will be used in the Labadie Sulfur Reduction Project. The training program will utilize and reference the QAPP, associated Standard Operating Procedures (SOPs), the manufacturer's instruction manuals and "hands-on" supervised instruction. On-site supervisory review of the field operator's work and performance will be made frequently at the beginning of the program, and will continue throughout the duration of the program.

Table A2: Key Project Personnel For The Labadie Sulfur Reduction Project		
Personnel	**Title**	**Organization**
Ken Anderson	Manager, Environmental Services	Ameren Services
Robert Laplaca	Project Manager	Ameren Services
Gary Mitchell	Project Engineer	Ameren Missouri
Dr. Howard M. Ellis	President	Enviroplan Consulting
David Cummings	Project Manager	Enviroplan Consulting
Kathleen M. Stanwood	Data Manager	Enviroplan Consulting
Thomas Ferrebee	Quality Assurance Coordinator	Enviroplan Consulting
Kevin Ruggiero	Sr. Monitoring Engineer	Enviroplan Consulting
TBD	Field Operator	Enviroplan Consulting
Keith Bertels	Overall Missouri Department of Natural Resources QA	MDNR
Stephen Hall	Department /Air Program Quality Assurance Coordinator (QAC)	MDNR
Patricia Maliro	Department Project Coordinator	MDNR
David Malorin	Quality Assurance Review	MDNR
Patricia Marliro, David Malorin	Department/External Technical Systems Auditing	MDNR

A.1.2 Major Functions

A successful ambient air monitoring program requires close coordination with and oversight by the regulatory authority in charge of the state or region in which the monitoring is being conducted. The MDNR has oversight of the monitoring program being conducted by Enviroplan Consulting for Ameren Missouri. The MDNR APCP's mission is to maintain the purity of Missouri's air to protect the health, general welfare and property of the people. Staff in the air quality monitoring section operates a variety of instruments at many locations around the state as part of a network to monitor air pollutants known to affect people's health. The MDNR's Environmental Services Program (ESP) staff audit the instruments in the statewide monitoring network as well as certain air monitors operated by private industry. Staff evaluates all procedures and documentation related to the collection of air quality data including maintenance and calibration of instruments and the precision, bias, and accuracy of monitoring data. The MDNR ESP's Air Quality Assurance Unit (AQAU) purpose is to ensure air data produced is of known quality and the quality level is adequate to meet monitoring objectives. The AQAU is responsible for planning, managing and performing all quality assurance activities in Missouri's ambient air monitoring network, including not only Missouri's network, but networks operated by private industries. The major functions of each of these key parties are described below.

Missouri Department of Natural Resources

APCP – Monitoring Unit

a. Coordinate state ambient air monitoring network.

b. Review and approve QAPPs.

c. Review and approve siting locations.

d. Review and approve monitoring reports, and provide comments as appropriate.

e. Conduct Technical Systems Audit once per year, per parameter, per consultant.

ESP – Air Quality Assurance Unit

a. Review and evaluate QAPPs and SOPs from industries.

b. Conduct additional external performance and technical systems audits on industry monitoring sites as appropriate.

c. Review and evaluate QA/QC data from industries as requested by the APCP.

d. Provide technical assistance to air monitoring field staff as requested.

e. Conduct Technical Systems Audit once per year, per parameter, per consultant.

Enviroplan Consulting

a. Collect continuous SO2 pollutant and meteorological data. Review data for errors and malfunctions and make corrections.

b. Report data and quality control and assurance assessments to Air Pollution Control Program. Reports are to be in hard copy and electronic format. Electronic data will be AQS format, with site identification.

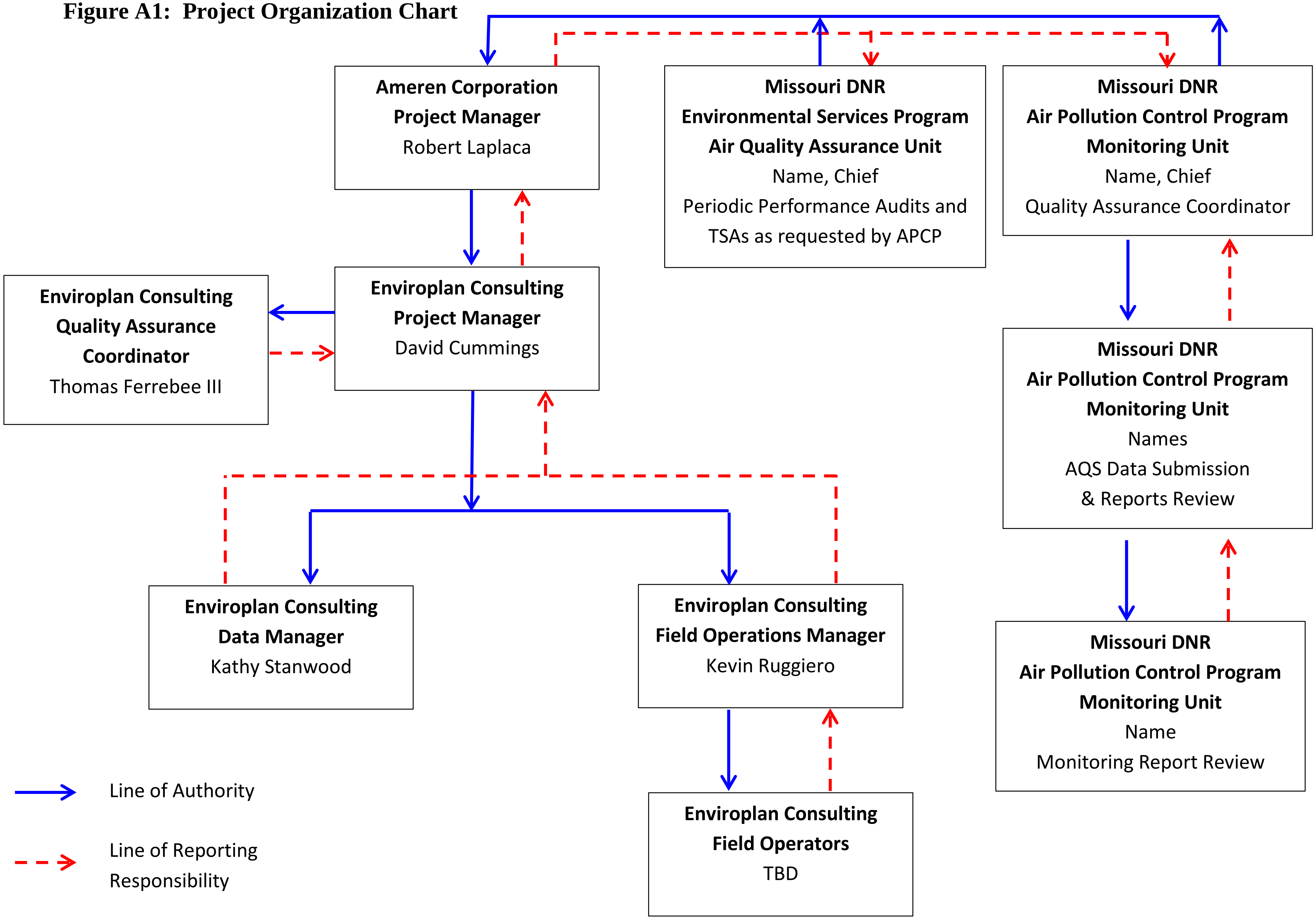
c. Perform required periodic checks of instruments at identified frequency. Evaluate instrument performance and take corrective action when needed. Maintain appropriate instrument and standard material certifications.

d. Evaluate the condition of field equipment and maintain equipment replacement schedule. Purchase equipment needed to complete monitoring commitments.

e. Install new sites; install and calibrate monitoring instruments.

f. Conduct performance and technical systems audits on monitoring sites.

Figure A1: Project Organization Chart



A2. PROBLEM DEFINITION/BACKGROUND AND PROJECT OBJECTIVE

Ameren operates the Labadie Energy Center, a coal-fired electric power generating station located at 226 Labadie Power Plant Road in Franklin, County, MO. The Labadie Energy Center is a power plant that converts the energy from coal and other fuels to produce steam that powers electrical generating equipment. There are four tangentially fired boilers on site. The installation has coal unloading, conveying, stockpiles and pulverizing equipment to supply the coal fired boilers. The facility is a source of sulfur dioxide (SO_2) and other pollutants.

A2.1 Purpose

To better assess ambient air concentrations of SO_2 with respect to the 1-hour SO_2 NAAQS, Ameren plans to implement an ambient air quality and meteorological monitoring program in the vicinity of the Labadie Energy Center.

The anticipated application of the monitoring data is to assess compliance with the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The fully quality-assured, validated monitoring data will be reported to the MDNR APCP. A table listing the 1-hour SO_2 NAAQS can be found in Appendix 5.

The duration of the monitoring program is anticipated to be to be three years, however, this period will be re-evaluated on an annual basis.

A2.2 Historical Background Information

The Labadie Energy Center began operation in 1970 and is authorized to operate in accordance with the rules and conditions of Operating Permit Number OP2011-020B, effective July 12, 2013. The Labadie Energy Center is located outside of Labadie, Missouri in Franklin County on 1,100 acres adjacent to the Missouri River, 35 miles west of St. Louis, MO.

The plant burns low-sulfur coal in its four operating units, producing up to 16 million pounds of steam per hour. The coal comes into the plant and is pulverized, giving it the consistency of face powder; the powdery coal is then blown into the boiler furnace. The steam flows into a turbine that turns a shaft in the generator; a magnet revolving inside a wire coil in the generator creates electricity.

A3. PROJECT/TASK DESCRIPTION

The objective of the ambient air monitoring program is to better assess ambient air concentrations of SO_2 with respect to the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The duration of the monitoring program is anticipated to be three years, however, this period will be re-evaluated on an annual basis.

Data quality objectives are presented in Section A4 and Appendix 4. Enviroplan Consulting will self-assess and report quarterly compliance with those data quality goals. If the goals are not met, documented investigation and corrective actions are required. Detailed descriptions of instrument response that does not meet acceptability limits and out-of-control situations are discussed in Sections B5, B6, and C1.

The monitoring program will be conducted in accordance with relevant MDNR requirements and guidance pertaining to air quality and meteorological monitoring and the following regulatory publications:

a) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013);

b) Ambient Monitoring Guidelines for the Prevention of Significant Deterioration (PSD) (EPA 450/4-87-007, May 1987)

c) EPA Requirements for Quality Assurance Project Plans (QA/R-5), EPA/240/B-01/003, March 2001);

d) Guidance for Preparing Standard Operating Procedures (SOPs) EPA QA/G-6; (EPA/240/B-01/004, March 2001);

e) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements Version 2.0 (Final) EPA-454/D-06-001, March 2008;

f) Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005, February 2000);

g) Ambient Air Monitoring QAPP Template, Revised 2014, Missouri Department of Natural Resources; and

h) Instructions on completing the MDNR/Ambient Air Monitoring QAPP Template, Missouri Department of Natural Resources.

Two monitoring stations are planned to be installed and operated in support of this project. Each monitoring station shall continuously measure and record ambient concentrations of SO_2. Additionally, meteorological parameters will be measured on a 10 meter (m) tower at one of the sites and will also be measured at approximately 30m and 65m on a tall tower located near the Labadie Energy Center. The meteorological measurements include the following:

- Horizontal wind speed (WS) (scalar and resultant vector);
- Vertical WS;
- The standard deviation of the Vertical WS (σ_W);
- Horizontal wind direction (WD) (scalar and resultant vector);
- The standard deviation of the wind direction (σ_θ) (scalar and resultant vector);
- Ambient air temperature (Temp);
- Temperature difference (ΔT);
- Relative humidity (RH);
- Precipitation (Precip); and
- Solar radiation (SR).

In keeping with this objective, the monitors will be located in the vicinity of the Labadie Energy Center while avoiding direct exposure to process areas and potential emission points. The monitor locations will provide comprehensive spatial coverage with respect to the Labadie Energy Center so as to obtain concurrent measurements at locations that are upwind and downwind of the Labadie Energy Center under varying meteorological conditions. A detailed description of the network design and site locations can be found in Section B1 of this QAPP. A table listing the monitoring sites location including latitude and longitude, photographs of the proposed monitoring sites toward each cardinal direction, a topographical map of the monitoring area showing the ambient air and meteorological monitoring stations, and background meteorological data are presented in Appendix 2.

Potential site locations were evaluated with respect to relevant air quality monitor siting and exposure criteria as published in 40CFR Part 58, Appendix E as well as practical considerations that include site availability, accessibility, security and proximity to existing utility services.

Additionally, locations for the two meteorological monitoring sites were evaluated with respect to the guidance contained in the U.S. EPA publications Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV-Meteorological Measurements, Version 2.0 (Final), *EPA-454/B-08-002,* March 2008 (EPA Vol. IV).

Northwest Monitoring Site ("Northwest Site") will monitor SO_2. It is situated approximately 3.2 km northwest of the Labadie Energy Center in a farm field located off of Route 94 in Augusta, Missouri. The land surface is typical of an active farm field and the monitor will be located so as to be away from any potential obstructions. Potential obstructions consist of heavily wooded areas that surround the farm field. The distance to the nearest of these wooded areas is 90 m, equivalent to approximately 9 to 10 times the height of the trees. The nearest distance from the monitor to Route 94 is 30 m. Spacing of the site from all roadways, obstructions and potential nearby sources conforms to relevant EPA siting and exposure guidelines for the pollutant compound to be monitored. The geographical coordinates of the NW Site are Latitude: 38º 34’ 54.48” N; Longitude: 90º 51’ 55.90” W.

Valley Monitoring Site (“Valley Site”) will monitor SO_2 and meteorological parameters. The Valley Site is located approximately 3.7 km east-northeast of the Labadie Energy Center in a farm field off of Labadie Bottom Road. The topography of the site locale is generally level except for minor grade changes ≤ 3.1m (10 feet) extending to the Labadie Energy Center. This site is situated on land with natural ground cover that is actively farmed and is virtually treeless extending to the Labadie Energy Center to the west and over 700 m in all other directions from the site. Labadie Bottom Road is an unpaved farm access road with minimal vehicular traffic. The geographic coordinates for the Valley Site are Latitude: 38º 34’ 21.08” N; Longitude: 90º 47’ 48.88” W.

Tall Tower Meteorological Monitoring Site (“Tall Tower Met Site”) is a meteorological monitoring site only. The Tall Tower Met Site is located approximately 4.7 km east of the Labadie Energy Center on an elevated stretch of wooded area off of Highway T. The meteorological parameters monitored at this site will be installed at the 30 m and 65 m levels of a 92 m tower. The tower is situated at the highest point on an elevated, treed area. A dense line of deciduous trees and a communication building are in the vicinity of the Tall Tower Site. The wind monitors will be measured at these heights to ameliorate any effects from communications equipment installed at higher heights on the tower. The geographic coordinates of Tall Tower Site are Latitude: 38º 33’ 43.15” N; Longitude: 90º 46’ 58.82” W.

Table A3 lists the monitoring sites’ location and geographical coordinates. Figure A2 presents an overhead view of the Labadie Energy Center with the locations of the monitoring sites depicted. Comprehensive descriptions of station siting specifications are presented in Section B of this document.

Table A3: Monitoring Sites Location and Geographical Coordinates

Site Designation	Location	Geographical Coordinates	UTM Coordinates NAD 83 Datum, Zone 15
Northwest Site	App. 3.2 km northwest of the Labadie Energy Center	Latitude: 38º 34’ 54.48” N; Longitude: 90º 51’ 55.90” W	4272530.402m Northing; 685920.407m Easting
Valley Site	App. 3.7 km east-northeast of the Labadie Energy Center	Latitude: 38º 34’ 21.08” N; Longitude: 90º 47’ 48.88” W	4271641.912m Northing; 691922.523m Easting
Tall Tower Site	App. 4.7 km east of the Labadie Energy Center	Latitude: 38º 33’ 43.15” N; Longitude: 90º 46’ 58.82” W	4270501.750m Northing; 693162.265m Easting

A3.1 Ambient Air and Meteorological Monitoring Measurements

The duration of the monitoring program is anticipated to be to be three years, however, this period will be re-evaluated on an annual basis. Sections A6.1.1 and A6.1.2 summarize the frequency and duration of monitoring by parameter. Table A4 lists the parameters to be monitored at each site and the sampling frequency for each parameter. Comprehensive descriptions of monitoring instrument performance specifications are presented in Section B of this document. Appendix 3 contains tables listing the parameters to be monitored at each site and the sampling frequency, range and units for each parameter at each monitoring site.

A3.1.1 Criteria Pollutants (SO_2)

Continuous monitoring instrumentation for ambient SO_2 is readily available and is considered typical for surveillance associated with tracking the NAAQS. Continuous monitoring instruments are reliable, impose minimal operation and maintenance requirements, and have typical useful life expectancies commensurate with the monitoring duration period. Consequently, SO_2 will be continuously measured using automated monitors that are designated by the U.S. EPA as equivalent methods for air quality monitoring programs. Measurement units for SO_2 concentrations will be measured in parts per billion (ppb). The raw measurement data will be averaged and archived as one-minute, five-minute and hourly block-averaged concentrations. Validated SO2 data will be reported as hourly-averaged concentrations, the maximum five-minute averaged concentration reported during each hour, the maximum hourly-averaged concentration reported each day, and 3-hour, non-overlapping, block-averaged concentrations. Additional data compilation and reporting for these pollutants are described in Sections A3.3 and A3.4 of this document.

A3.1.2 Meteorological Monitoring

Specific meteorological parameters will be continuously monitored to obtain data representative of prevailing meteorological conditions for the Labadie Energy Center area of interest. Continuously measured meteorological parameters for this project will include one-minute, five-minute and hourly-averaged (scalar and resultant vector) measurements of horizontal wind speed and wind direction, the standard deviation of the scalar and resultant vector horizontal wind direction (σ_θ), vertical wind speed and the standard deviation of the vertical component of wind speed (σ_W), air temperature and temperature difference, relative humidity, solar radiation, and barometric pressure. Precipitation will also be measured and recorded as one-minute, five-minute and hourly accumulation values. Wind direction and sigma theta measurement data will be compiled and reported as five-minute and hourly block averages in degrees (^{o}), rounded to the nearest whole degree. Wind speed data measurement data will be compiled and reported as five-minute and hourly block averages in miles per hour (mph), rounded to the nearest tenth of a mph. Air temperature and temperature difference measurement data will be compiled and reported as five-minute and hourly block averages in degrees Fahrenheit (^{o}F), rounded to the nearest tenth of a degree. Relative humidity measurement data will be compiled and reported as five-minute and hourly block averages in percent (%), rounded to the nearest whole percent. Barometric pressure will be compiled and reported as five-minute and hourly block averages in millibars (mB), rounded to the nearest whole millibar. Solar radiation will be compiled and reported as five-minute and hourly block averages in Watts per square meter (W/m^2). Precipitation will be compiled and reported as five-minute and hourly accumulation in tenths of an inch (in.) increments.

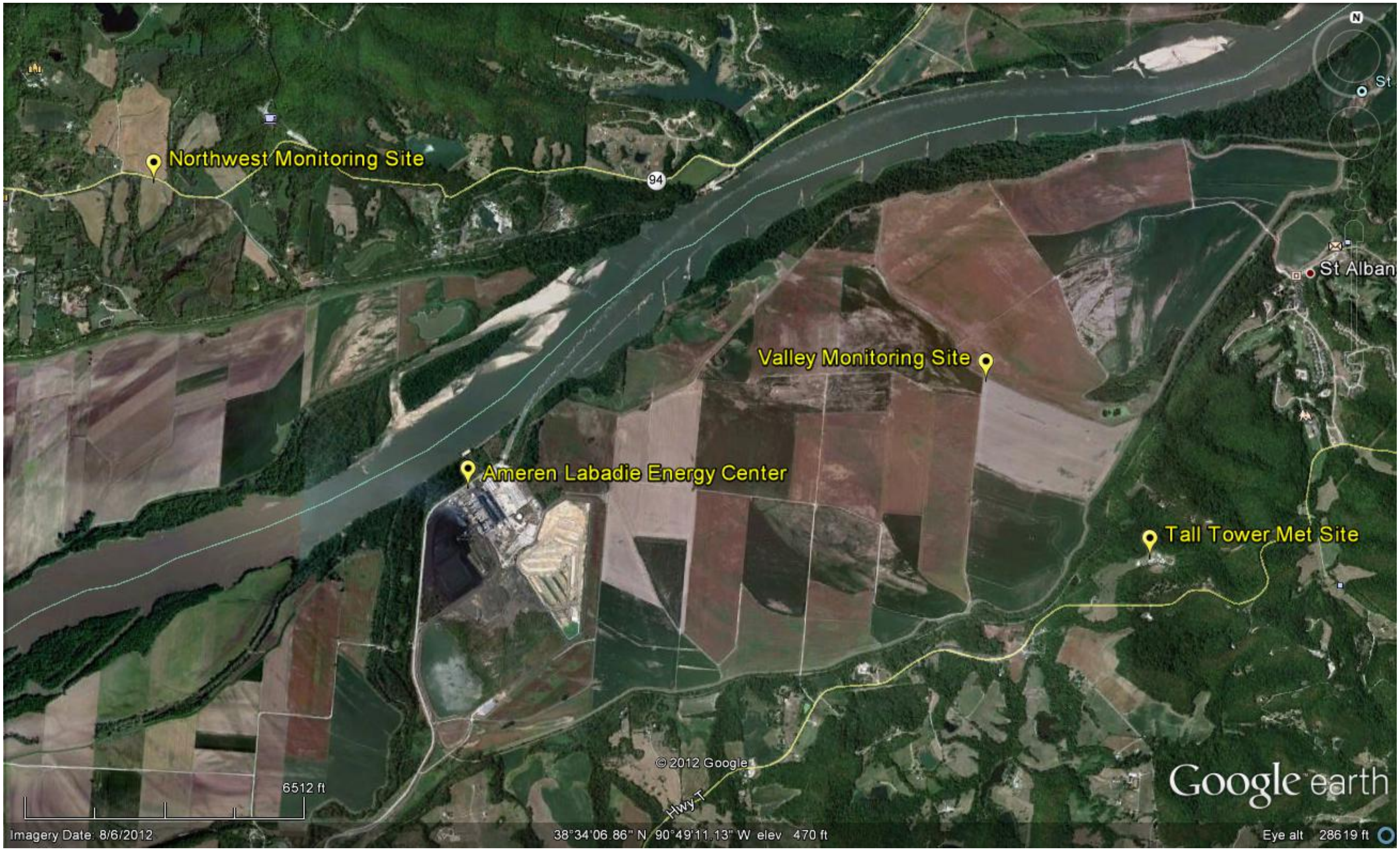
Table A4: Monitoring Sites and Parameters for the Labadie Sulfur Reduction Project				
Monitored Parameters	**Measurement Frequency, Range and Units**	**Probe Level (meters)**	**Measurement Reporting Resolution**	**Instrument / Method**
Northwest Site				
SO_2	Continuous 0 to 500 ppb	3	1 ppb	Ultraviolet fluorescent
Valley Site				
SO_2	Continuous 0 to 500 ppb	3	1 ppb	Ultraviolet fluorescent.
Horizontal Wind Speed	Continuous 0 to 125.0 mph	10	0.1mph	Cup Anemometer
Horizontal Wind Direction[1]	Continuous 0 to 360º	10	1º	Vane
Sigma Theta (Standard Deviation of Wind Direction)[2]	Continuous 0 to 100º	10	1º	Calculated
Vertical Wind Speed	Continuous ±25 mph	10	0.1mph	Propeller Anemometer
Sigma W (Standard Deviation of Vertical Component of WS)	Continuous 0 to 25 mph	10	0.1mph	Calculated
Ambient Air Temperature	Continuous -22° to +122°F	2	0.1ºF	Aspirated RTD
Air Temperature	Continuous -22° to +122°F	10	0.1ºF	Aspirated RTD
Temperature Difference	Continuous °F	10-2	0.1ºF	Calculated
Relative Humidity	Continuous 0 to 100%	2	1%	Aspirated Thin film polymer capacitor
Solar Radiation	Continuous 0-1,495 W/m^2	1	1 W/m^2	Thermopile-Type Detector
Barometric Pressure	Continuous 900 to 1100 mbar	1.5	1mb	Capacitive Transducer
Precipitation	Continuous 0 to unlimited inches	1.0	0.01 inches	Tipping bucket

Table A4: Monitoring Sites and Parameters for the Labadie Sulfur Reduction Project				
Monitored Parameters	**Measurement Frequency, Range and Units**	**Probe Level (meters)**	**Measurement Reporting Resolution**	**Instrument / Method**
Tall Tower Site				
Horizontal Wind Speed	Continuous 0 to 125.0 mph	65, 30	0.1mph	Cup Anemometer
Horizontal Wind Direction[1]	Continuous 0 to 360º	65, 30	1º	Vane
Sigma Theta (Standard Deviation of Wind Direction)[2]	Continuous 0 to 104º	65, 30	1º	Calculated
Vertical Wind Speed	Continuous ±25 mph	65, 30	0.1mph	Propeller Anemometer
Sigma W (Standard Deviation of Vertical Component of WS)	Continuous 0 to 25 mph	65, 30	0.1mph	Calculated
Air Temperature	Continuous -22° to +122°F	65, 30	0.1ºF	Aspirated RTD
Temperature Difference	Continuous °F	65-30	0.1ºF	Calculated

NOTES:

1. Scalar-averaged and resultant-vector values for wind direction will be collected for horizontal wind direction.
2. The standard deviation of the scalar horizontal wind direction will be calculated using the Yamartino method and a wind speed weighted algorithm for resultant vector values. For an hourly average, the standard deviation will be calculated based on four 15-minute values averaged to minimize the effects of wind meander associated with light wind speed conditions and also using all 3600 samples during that hour.

2. **Figure A2: Aerial View of Labadie Energy Center with Monitoring Site Locations**



A3.2 Work Schedule

Ameren operates the Labadie Energy Center in Labadie, Missouri. The Labadie Energy Center generates electricity for wholesale and retail distribution. The objective of the ambient air monitoring program is to better assess ambient air concentrations of SO_2 with respect to the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center.

In support of the ambient air monitoring program, Ameren contracted with Enviroplan Consulting to furnish, supply, install and operate the Labadie Sulfur Reduction Project. Enviroplan Consulting, a qualified company that, since 1974, has specialized in the measurement and study of air pollution and meteorology, was selected to provide the monitoring systems and provide the operations and maintenance of the monitoring program.

The duration of the monitoring program is anticipated to be to be three years, however, this period will be re-evaluated on an annual basis.

A3.2.1 Engineering

This work is the first phase of performance for the project. Enviroplan Consulting developed and submitted to Ameren's Project Engineer drawings detailing the system design and site construction drawings of each of the monitoring stations.

A3.2.2 Quality Assurance Project Plan (QAPP) Development

Enviroplan Consulting has developed and submitted this Quality Assurance Project Plan (QAPP) to Ameren for review and approval by the MDNR APCP. This QAPP is specific to the Labadie Sulfur Reduction Project monitoring program. Electronic files of the QAPP will be provided in Microsoft® Word or PDF format. The QAPP is a controlled document distributed to specified individuals affiliated with project stakeholder entities (e.g., regulatory agencies with project oversight responsibilities, the project owner, operating contractor project personnel, etc.). The content and organization of the QAPP will conform to the guidance contained in the following regulatory publications:

a) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013);

b) EPA Requirements for Quality Assurance Project Plans (QA/R-5), EPA/240/B-01/003, March 2001);

c) Guidance for Preparing Standard Operating Procedures (SOPs) EPA QA/G-6; (EPA/240/B-01/004, March 2001);

d) EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements Version 2.0 (Final) EPA-454/B-08-002, March 2008;

e) Ambient Air Monitoring QAPP Template, Revised 2014, Missouri Department of Natural Resources; and

f) Instructions on completing the MDNR/Ambient Air Monitoring QAPP Template, Missouri Department of Natural Resources.

The QAPP fully describes all monitoring systems and equipment used in the program. The purpose, goals and objectives of the program are discussed, together with program-specific organization, responsibilities, monitoring methodologies, quality assurance and quality control (QA/QC) elements.

The QAPP provides detailed information for monitoring activity documentation, procedures, use and maintenance of all monitoring equipment, test equipment and calibration standards, as well as procedures for conducting independent quality assurance technical and systems audits of each instrument's performance and overall conformance with established Standard Operating Procedures and data quality objectives. The QAPP also contains detailed instructions on data transmission, data handling, data reduction, data validation and data reporting.

Project-specific Standard Operating Procedures (SOP's) for the monitoring equipment and program activities are included as part of the QAPP. Each SOP contains detailed, step-by-step instructions on monitor installation, performing routine operation, calibrations, control checks, preventive maintenance, troubleshooting, recommended stocks of spare parts, required consumables, and all other tasks associated with operating and maintaining the instruments.

This QAPP may be revised if substantive changes occur to the monitoring program or in response to comments received from the MDNR APCP or Ameren. Any revisions to this QAPP are subject to the approval of the MDNR APCP.

A3.2.3 Equipment Procurement, Assembly, Factory Acceptance Tests and Delivery

Enviroplan Consulting has procured all equipment and materials for the monitoring program on behalf of Ameren, who is the owner of record of the monitoring equipment and associated materials. Enviroplan Consulting also developed and supplied Ameren with all drawings and engineering documentation for the monitoring program.

The monitoring system equipment has been subjected to acceptance testing at Enviroplan Consulting's assembly and test facility in Wayne, NJ. Received monitoring instruments and materials have been visually inspected for integrity and conformance with manufacturer's specifications. Following satisfactory visual inspection and verification of conformance to purchase order specifications, the monitoring equipment was powered on and tested for correct operation at Enviroplan Consulting's assembly and test facility in Wayne, NJ, first as individual instruments and subsequently as complete, integrated monitoring systems configured as specified for installation and operation in the field. All factory inspections, assembly and testing are performed by Enviroplan Consulting's trained and experienced Monitoring Division technical staff in accordance with approved engineering documentation.

During factory acceptance testing, data acquisition system (DAS) software programming and configuration is checked for conformance to defined functions, measurement ranges and other configuration parameters. DAS functions and scaling accuracy will be confirmed using known, NIST-traceable electrical test signal inputs as surrogates for monitor measurement signals. PC-based data application software will be configured to acquire, store, process the data and produce desired reports. Data transmission and acquisition functions between the data logger and the PC application software will be tested for proper operation.

After individual testing of the equipment is completed, the monitoring instruments and support equipment are connected and integrated as they will be operated in the field. The instruments are calibrated in accordance with the approved QAPP and associated SOPs and allowed to operate under conditions that closely approximate actual field operating conditions for several weeks. During this interval, comprehensive operating status checks are performed and documented on each instrument undergoing testing at minimum two-day intervals. Data from the pollutant monitors is acquired daily and collected via the configured system DAS. Periodic calibration, one-point quality control checks for precision and bias, and other quality control checks are performed and results documented. The recorded test data is reviewed by the technical staff to confirm correct, stable operation and that instrument performance conforms to the manufacturer's and engineering specifications.

A3.2.4 System Delivery, Installation and Site Acceptance Tests

Following satisfactory completion of the factory acceptance tests, Enviroplan Consulting protectively packs and delivers all equipment with detailed bills of lading to Ameren.

Following delivery to Ameren, an inventory is taken of the equipment and the equipment is temporarily stored at the Labadie Energy Center pending completion of monitoring site preparation and construction in accordance with the engineering documentation furnished by Enviroplan Consulting. Monitoring site preparation and construction includes construction of site access roads as required, grading and raising the elevation of the monitoring site compound area as needed, construction of footer blocks for new meteorological towers, construction of support pads for the monitoring shelters, construction of gated, chain-link security fencing, and delivery of electric utility service to the monitoring site locations as needed.

Following completion of monitoring site construction, the monitoring shelters are installed and electric service attachments are made to the monitoring stations. All electrical work and materials conform to the National Electric Code (NEC) and local code requirements. Monitoring shelters are factory-constructed by EKTO Manufacturing Corp. in accordance with approved, sealed engineering designs, construction methods and materials. Enviroplan Consulting Senior Monitoring Engineers then arrive on site to assist with monitoring system installation in conformance with the engineering documentation and approved QAPP.

Following completion of monitoring systems field installation, the system is tested for proper operation and functional performance. Enviroplan Consulting's Monitoring Engineers apply power to the instruments and perform a documented check of component/systems operating functions to confirm the operational integrity of the installed monitoring systems. Operational integrity checks will include verifying:

- Correct functioning of each pollutant and meteorological monitor;
- Confirmation of correct monitor I/O signals and acquisition and recording of monitor I/O signals by each station data acquisition systems (DAS);
- Confirmation of automated and manual system control functions, including execution and recording of results of automatic calibration checks performed on each pollutant monitor;
- Correct functioning of all sample intake systems;
- Comprehensive checks of each station DAS and data transmission functions via the installed wireless data modems. This will include verifying correct automatic data transmission from each monitoring system, receipt and recording of the data by the central data management system, and verifying correct central data acquisition system functionality for remote interrogation of each station DAS the pollutant monitors installed at each station.

Upon confirming correct system functions and operating status, the pollutant monitors are allowed to operate normally for a minimum overnight period to stabilize. Initial multi-point calibrations will be performed on each monitor using certified calibration standards and equipment traceable to the National Institute of Standards and Technology (NIST) in accordance with the approved QAPP and relevant SOPs.

A3.2.5 <u>Operate and Maintain the Monitoring Network</u>

Early in the project, Enviroplan Consulting conducts a recruiting campaign, selects and hires a qualified individual for the position of local field operator for the monitoring stations. The field operator will have a background in air quality monitoring, electronics or instrumentation. The field operator will complete an extensive hands-on training program conducted by Enviroplan Consulting. The training program is specific to the air monitoring program requirements and monitoring instruments. The equipment designated for supply for the monitoring program will be utilized in the training program. Support materials for the field operator training program include the manufacturer’s instrument manuals, project-specific SOPs and the approved QAPP.

Our local field operator will perform all routine, day-to-day operation and maintenance services for the monitoring stations in accordance with the regulatory guidelines and requirements applicable to the monitoring program. The field operator will be supported in this work by the experienced staff of Enviroplan Consulting's Monitoring Division. The following lists the activities performed by the local field operator in support of network operation and maintenance:

- Routine Station Checks and Preventive Maintenance
- Preventive Maintenance
- Corrective Maintenance
- Routine Data Management and Response to Out-of-Control Alarm Conditions

A3.2.6 Quality Assurance Program

Tables A8, A9 and A10 in Section A4 summarize routine quality assurance (QA) and quality control (QC) activities, the minimum frequency for which these checks and activities will be performed, associated acceptance criteria, control limits and corrective actions as pertains to the continuous gaseous pollutant and meteorological monitoring systems.

A formal program of daily data review, reporting irregularities, non-conformance or deviation from the QAPP, Out-of-Control instrument operating conditions, or audit failure to the Project Manager ensures that any problems will be promptly identified, addressed and resolved, thereby ensuring the quality of the data and integrity of the program.

Table A5 provides a summary of the tentative work schedule for this monitoring project.

Table A5: Work Schedule for the Labadie Sulfur Reduction Project

Project Task		Target Date
Develop Monitoring System Design and Site Construction Drawings		Prior to Equipment Ordering and Acquisition
Equipment Ordering and Acquisition		12 to 16 Weeks before Monitoring Program Startup
Develop QAPP and SOPs		Prior to Field Installation and Startup
Receive Equipment and Acceptance Test		4 to 6 weeks after Equipment Ordering
Field Operator Training		Prior to Monitoring Program Start Up
Integrate Equipment, Assemble and Final Test		Prior to Delivery for Field Installation
Field Installation and Start Up Calibration		September 2014 Start-up Calibration upon completion of Field Installation
Systems & Performance Audit		Within 30 days of start-up and Annually thereafter
Ambient Air Monitor Audit		Each Analyzer Once per Quarter
Meteorological Audits		Semi-annually
Operations and Maintenance	Data Download & Review Site Checks Auto Level 1 Zero/Span Check Auto Zero/Span/QC Check Calibrations Preventative Maintenance	Daily Weekly Daily Weekly Every 180 days or as necessary Per schedules in instrument SOPs
Data Reports		Monthly to Ameren, Quarterly to MDNR (within 60 days of the end of the quarter)
Monitored NAAQS Exceedance Reports to APCP		Within 30 days of occurrence

A3.3 Required Project Records and Reports

Enviroplan Consulting will submit monthly and quarterly reports of the air monitoring data collected during the most recent, previous reporting period to Ameren. The hourly-averaged, validated data will be submitted to Ameren within 35 days following the end of each monthly reporting period.

A3.3.1 <u>Monthly Reports</u>

Each monthly data report will include a missing data report that lists all missing data by parameter, the hours affected and an explanation of the reason why the data are reported as missing or invalid. Invalid data are not included in any of the summary statistics.

The information reported for each monitoring station will include:

- Sequential, hourly listings (hard copy, tabular form and in U.S. EPA AQS format on a data CD or electronic transfer via email or file transfer protocol) of validated hourly gaseous and particulate pollutant and meteorological data (hard copy, tabular form and on a data CD or via electronic file transfer via email or file transfer protocol in U.S. EPA AQS format);
- Concentration summaries for all measured pollutants, including year-to-date, highest and second-highest hourly block averages;
- Three-hour rolling averages of SO_2 data, including highest and second-highest values;
- Daily maximum hourly average of SO2 data;
- The maximum 5-minute SO2 concentration recorded for each hour;
- Meteorological hourly-averaged data listings on a monthly, quarterly, and annual basis including: average, maximum and minimum wind speeds, and joint frequency distributions of wind speed and wind direction (tabular and as wind roses);
- Comparison of measured pollutant concentrations with applicable National Ambient Air Quality Standards in units consistent with those criteria. Exceedances of the respective standards, if any, will be identified and discussed in a letter report within one business day of occurrence.

A3.4.1 <u>Quarterly Reports</u>

A quarterly quality assurance data report will be submitted to Ameren within 45 days following the end of each quarterly reporting period. Each quarterly data report will be submitted both as a bound hard copy and as an electronic file on CD in PDF format. The data listings will be reported in U.S. EPA AQS format on hardcopy and on the CD.

Each quarterly data report will include a missing data report that lists all missing data by parameter, the hours affected and an explanation of the reason why the data are reported as missing or invalid. Invalid data are not included in any of the summary statistics.

The content of each quarterly data report will include tabular data averages for each month (as described for the monthly data reports above as well as:

- Relevant calibration, precision, bias, and accuracy data and statistics;
- Data recovery rates and explanations of missing data periods; and
- Results from independent performance and systems audits.

The results of monitor performance checks are presented in an appendix to the monitoring data report. They are presented in tabular form and discussed with respect to conformance with applicable precision, bias, and accuracy objectives along with the conventions used for calculating these parameters. Monthly and quarterly data recovery rates and explanations of missing data periods will also be summarized. Finally, the quarterly QA data report will contain copies of the various quality assurance check forms completed during the current reporting period (i.e., calibration data, Level 1 zero/span and one-point quality control checks and independent performance and systems audits).

Additional reports to be generated include Performance Audit Reports for the Gas Analyzers, Performance Audit Reports for the Meteorological Sensors, Corrective Action Reports and Response to Corrective Action Reports. All deficiencies and concerns identified during audits, site visits, and/or during data review will be recorded and reported to the Project Manager within seven working days of discovery. Any participant in the monitoring program may initiate a corrective action, if needed. Corrective actions to deficiencies will be addressed and documented in a Site Checklist form and in the audit reports. Any corrective actions will also be discussed in the annual data reports. All corrective action forms are reviewed by the Enviroplan Project Manager and as necessary, reported to the Ameren Project Manager for their review.

In addition to the above mentioned reports, a Station Logbook will be maintained at each site and will document all activities that take place at that site, including routine operations and maintenance, summary of any calibrations and audits, and any other items outside the normal operations of the monitoring program.

The required project reports to be generated and schedule are summarized in Table A6.

Table A6: Required Project Reports for the Labadie Sulfur Reduction Project	
Item	**Schedule**
Installation Report	Report to be written when system installation is complete
Monitored NAAQS Exceedence Report	Report to be submitted to APCP within 30 days of occurrence
Monthly Data Summaries	Report to be written monthly
Calibration Checks	Task to be performed every 180 days for pollutant monitor, semi-annually for meteorological monitors Calibration reports to be included in quarterly data summaries
Data Precision and Bias	Task to be performed quarterly
Quarterly Data Summaries	Report to be written after any calibration checks are complete and after quarterly audit reports are received Report to be submitted to APCP within 60 days of the end of the quarter
System Audits	Task to be performed (a) within 30 Days of system installation and (b) quarterly (for air quality monitors) and (c) semiannually (for meteorological monitors) Task report to be written and submitted (by QA/QC Auditor) within 30 days of each respective system audit
Performance Audits	Task to be performed (a) within 30 Days of system installation and (b) quarterly (for air quality monitors) and (c) semiannually (for meteorological monitors) Task report to be written and submitted (by QA/QC Auditor) within 30 days of each respective performance audit
Corrective Action Reports/Response to Corrective Action Reports	As needed.

A4. QUALITY OBJECTIVES AND CRITERIA

As stated in Section A3.1 of this document, the rationale for implementing the Labadie Sulfur Reduction Project is to assess compliance with the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. Consequently, measurement data produced by the monitoring program should be of sufficient quality to be meaningfully compared with corresponding state and federal air quality standards pertaining to the monitored air pollutants. Similarly, meteorological data should meet minimum standards established use in air modeling applications. Accordingly, Table A8 lists measurement data quality objectives (MDQOs) for monitoring data completeness, data accuracy, and (as applicable) data precision and bias.

For the project to meet the MDQOs, the monitoring must be done in accordance with established protocols. Table A9 and Table A10 list quality control and quality assurance checks and activities that are to be periodically performed on each monitoring system. Quantified results of these checks are evaluated against established control limits and acceptance criteria. In the event that a measurement system exceeds one or more established control limits, a regime of investigative and corrective actions will be implemented by the operating group to restore the affected instrument to acceptable operating condition. These activities, together with appropriate training, project organization and management structures, will assure the data produced by each monitor consistently meet the MDQOs.

As a means of assuring the collection of high-quality data and meeting the requirements of the MDNR APCP, the Quality Assurance/Quality Control (QA/QC) procedures summarized in this section will be followed. Results of all field QA/QC checks and activities, preventive and corrective maintenance, sampling activities and other, miscellaneous monitoring activities will be documented by the field operator in bound, numbered-page, chronological logbooks maintained at each monitoring station and also on forms specifically developed for each QA/QC check and monitoring activity. Detailed instructions for performing the activities referenced in this section will be presented in the Standard Operating Procedures (SOPs).

Field documentation forms will routinely include identification of the monitoring network, site, monitor make, model and serial number, date and Begin/End times of the activity or check, the field operator’s name, calibration standards used, known test inputs or expected “target” responses, observed monitoring instrument responses, evaluation of the observed responses with respect to established acceptability or control limits, and clear identification of “As Found” (unadjusted) check results, any adjustments made to the monitoring instrument or maintenance performed subsequent to performing “As Found” checks and tests, and clear identification of all “As Left” check or test results.

Completed quality assurance field documentation forms are signed by the operator and forwarded monthly with all other field data to a centrally-located Data Management Department for review in support of data validation. The documentation and data records are then archived for a period of five years.

A4.1 Ambient Air Monitoring for SO_2

A4.1.1 Calibration

Continuous SO_2 monitors will be calibrated upon initial installation, relocation, or following an interruption of more than a few days and will be recalibrated whenever any one of the following conditions occurs:

- Level One Span or One-Point QC Check exceeds ±10 percent.
- Before (for functional monitors) and after repair or significant maintenance activities of an analyzer.
- Before (for functional monitors) and after replacement of a major component (or components) of an analyzer.
- Audit values exceed ±10 percent.
- After a maximum of 6 calendar months have elapsed since the last calibration.

Gaseous pollutant monitors will be calibrated in situ without disturbing the normal sampling train (except for transferring the sample inlet line from the ambient sampling manifold port to the calibration system manifold port for the duration of the calibration event). A minimum of two non-zero upscale known concentrations and a zero point will be generated to determine each analyzer's calibration relationship and linearity.

Concentrations of the SO_2 calibration test gas will be generated by the dilution of an EPA Protocol G-1 standard gas using a gas calibration system and a zero air generator (the gas dilution calibration system) as described in Section B7. The calibrations will be conducted in accordance with relevant sections contained in the "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Quality Monitoring Program", (EPA-454/B-13-003, May 2013) and 40 CFR Part 50 Appendix A.

A4.1.2 Level 1 Zero and Span Check

A Level 1 zero and span check of the continuous gaseous pollutant analyzers will be carried out at a minimum frequency of once every two weeks. At the start of the monitoring program, the digital acquisition system will be configured to automatically initiate a Level 1 zero and span check of the analyzers. The Level 1 zero and span check will be conducted by subjecting the analyzer to test gas atmospheres at zero and one upscale concentration between 70 and 90 percent of the measurement range. Each analyzer will be operated in its normal sampling mode during the zero and span check. The test atmosphere will pass through all filters and components used during normal sampling operations and as much of the ambient air inlet system as practical. The Level 1 zero and span checks will serve as:

- A decision point on when to calibrate the analyzer

- A decision point on invalidation of monitoring data

A4.1.3 One-Point Quality Control Check

A one-point quality control (QC) check of each continuous gaseous pollutant analyzers will be performed at a minimum frequency of once every two weeks. This check will be automatically initiated by the digital acquisition system. The one-point QC check will be conducted by challenging the SO_2 analyzers with a known test gas concentration between 0.010 and 0.100 ppm. Each one-point QC check will be performed while each analyzer is operated in its normal sampling mode with the QC test gas passing through all filter and components used during normal sampling and as much of the sampling inlet system as practical. If the one-point QC check is conducted in conjunction with zero/span adjustments, it will be performed prior to any such adjustments. At the end of each sampling quarter, data obtained from the one-point QC check will be used in calculations for data quality assessments of precision and bias for each analyzer.

The goal for acceptable measurement uncertainty for precision is defined as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 10 percent.

Percent Difference. All measurement quality checks start with a comparison of a known concentration to the concentration measured by the analyzer and use percent difference as the comparison statistic as described in Equation 1 of this section. For each single point QC check, calculate the percent difference, d_i, as follows:

$$d_i = \frac{Y_i - X_i}{X_i} x100 \qquad (1)$$

Where

Yi = analyzer’s indicated concentration from the i-th one-point QC check
Xi = known concentration of the test gas used for the i-th one-point QC check

Precision Estimate. The precision estimate is used to assess the one-point QC checks for each SO2 analyzer. The precision estimator is the coefficient of variation upper bound and is calculated using Equation 2 of this section

$$CV = \sqrt{\frac{n \times \sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2}{n(n-1)}} \times \sqrt{\frac{n-1}{X_{0.1,n-1}^2}} \qquad (2)$$

where, $X^2_{0.1,n-1}$ is the 10th percentile of a chi-squared distribution with n–1 degrees of freedom.

Bias Estimate. The bias estimate is calculated using the one-point QC checks for each SO2 analyzer. The bias estimator is an upper bound on the mean absolute value of the percent differences and is calculated using Equation 3 below:

$$|AB| = AB + t_{0.95,n-1} \times \frac{AS}{\sqrt{n}} \tag{3}$$

where, n is the number of single point checks being aggregated; $t_{0.95,n-1}$ is the 95th quantile of a t-distribution with n–1 degrees of freedom; the quantity *AB* is the mean of the absolute values of the *di*'s and is calculated using Equation 4 of this section:

$$AB = \frac{1}{n} \times \sum_{i=1}^{n} |d_i| \tag{4}$$

and the quantity *AS* is the standard deviation of the absolute value of the *di*'s and is calculated using Equation 5 of this section:

$$AS = \sqrt{\frac{n \times \sum_{i=1}^{n} |d_i|^2 - \left(\sum_{i=1}^{n} |d_i|\right)^2}{n(n-1)}} \tag{5}$$

Assigning a sign (positive/negative) to the bias estimate. A sign (positive/negative) is assigned to the bias estimate. Since the bias statistic as calculated in Equation 3 of this section uses absolute values, it does not have a tendency (negative or positive bias) associated with it. A sign will be designated by rank ordering the percent differences of the QC check samples from a given site for a particular assessment interval.

The 25th and 75th percentiles of the percent differences for each site are calculated. The absolute bias upper bound should be flagged as positive if both percentiles are positive and negative if both percentiles are negative. The absolute bias upper bound would not be flagged if the 25th and 75th percentiles are of different signs.

Validation of Bias Using the One-Point QC Checks. The annual performance evaluations for each SO_2 analyzer are used to verify the results obtained from the one-point QC checks and to validate those results across a range of concentration levels. To quantify this annually at the site level, probability limits will be calculated from the one-point QC checks using Equations 6 and 7 of this section:

$$Upper\ Probability\ Limit = m + 1.96 \times S \tag{6}$$

$$Lower\ Probability\ Limit = m - 1.96 \times S \tag{7}$$

where, *m* is the mean (Equation 8 of this section):

$$m = \frac{1}{k} \times \sum_{i=1}^{k} d_i \tag{8}$$

where, *k* is the total number of one point QC checks for the interval being evaluated and *S* is the standard deviation of the percent differences (Equation 9 of this section) as follows:

$$S = \sqrt{\frac{k \times \sum_{i=1}^{k} d_i^2 - \left(\sum_{i=1}^{k} d_i\right)^2}{k(k-1)}} \tag{9}$$

Estimates of precision and bias data will be submitted to the MDNR APCP each quarter in both hard copy and in electronic format, e.g., AQS format.

A4.1.4 <u>Independent Audits</u>

Each continuous gaseous pollutant analyzer will be audited once per calendar quarter when routine sampling is occurring. A November 10, 2010 memorandum from the U.S. EPA supported expansion of allowable audit ranges and for the selection of non-consecutive audit levels while still auditing a minimum of three audit levels. The independent audit of gaseous pollutant analyzers for the monitoring program will consist of challenging the analyzers with a zero test gas and at least three upscale audit gas of known concentration within each of the following ranges:

Table A7: Continuous Gas Analyzer Audit Concentration Ranges

Audit Point	SO_2 Concentration Range (ppm)
0	0.000
1	0.0500 – 0.0999
2	0.1500 – 0.2599
3	0.2600 – 0.7999

During each audit, each analyzer will be operated in the normal sampling mode, with the audit test gas passing through all filters and components used during normal sampling operations and as much of the sampling system inlet line as practical. Audit results will be documented on a standard audit report form for continuous gaseous pollutant analyzers.

The personnel, standards, and equipment used to perform the audit will be completely independent of those used for normal network operation. Requests by qualified outside parties, such as the MDNR APCP, to conduct an audit of the monitors will be accommodated provided adequate advance notice (~ 2 weeks) is provided.

A4.2 Meteorological Monitoring

Quality assurance of the meteorological equipment will be conducted by standard calibration methods based on procedures described in the "Quality Assurance Handbook for Air Pollution Measurement System: Volume IV- Meteorological Measurements Version 2.0 (Final)" (*EPA-454/B-08-002*, March 2008), hereinafter referred to as Volume IV of the U.S. EPA Quality Assurance Handbook.

At the time of network startup, a complete calibration will be performed on each meteorological monitoring system, including performance assessments of the sensors' and overall system accuracy, as well as other critical operating parameters (e.g., starting torque of wind sensors). Calibration procedures that encompass complete sensor/system performance tests are identical to those utilized for quality assurance performance audits. These test methods are discussed in more detail below.

Following initial startup calibrations, and continuing throughout the monitoring program, the field operator will routinely perform weekly site checks on the meteorological monitoring systems. In the course of these checks, sensors will be observed for proper operation. The current data logger and strip chart readings will be assessed for agreement with prevailing conditions. At (minimum) monthly intervals, a two-point calibration check of the signal conditioning modules and corresponding data acquisition system responses will be performed.

Subsequent to initial startup calibrations, performance audits will be conducted on the meteorological monitoring systems at semi-annual intervals.

The performance audit of all wind speed measurement systems will use the MSI method described in Section 2.7.2 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of imparting a controlled rate of rotation on the impeller shaft via a calibrated direct-current motor to simulate selected wind speeds. The starting threshold of the anemometer will be assessed with a torque watch.

The performance audit of wind direction system will use the sensor control method described in Section 2.7.3 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method describes the relative performance of the wind vanes as a shaft-position transducer and the orientation of the transducer with respect to true north. The former is done with a fixture, part of which is mounted to the transducer body and part is mounted to the shaft in place of the vane. The latter requires the determination of true north (MSI method SN008) and a setting of the transducer relative to the orientation.

The performance audit of the air temperature measurement system will use the sensor control method as described in Section 3.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of immersing the temperature probe and audit transfer standard(s) into stable thermal masses (i.e., insulated water baths) at three different temperatures: and ice slurry, an “ambient” bath and a hot bath.

The performance audit of the precipitation measurement system will use the sensor control method as described in Section 4.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This test method consists of challenging the gauge with amounts of water known to an accuracy of one percent of the total used. Using the manufacturer’s transfer function for the gauge, the equivalent amount of rainfall can be calculated and compared to the measurement system’s indication. This method determines the measurement system accuracy but not the collection efficiency of the gauge in natural precipitation. For tipping bucket gauges, a rate of less than one inch per hour will be used and an amount which will result in a minimum of 10 tips.

The performance audit of the relative humidity system will be made using the Collocated Transfer Standard (CTS) method described in Section 5.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the relative humidity sensor of the system under test and obtaining a series of comparison measurements over time (typically over the course of several hours). The average difference is the reported system error.

The performance audit of the solar radiation system will be made using the Collocated Transfer Standard (CTS) method described in Section 6.9 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the pyranometer of the system under test and obtaining a series of comparison measurements over time (typically a full diurnal cycle). The average difference is the reported system error.

The performance audit of the barometric pressure system will be made using the Collocated Transfer Standard (CTS) method described in Section 7.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the barometric pressure sensor of the system under test and obtaining a series of comparison measurements over time (typically over the course of several hours). The average difference is the reported system error.

Personnel, standards, and equipment used will be completely independent of those used for routine operations. A quality assurance audit report will be generated following completion of each meteorological audit. The results of this report are forwarded to the Enviroplan Consulting Project Manager. The Project Manager will ensure appropriate action is taken with regard to the audit results and recommendations.

TABLE A8: MEASUREMENT DATA QUALITY OBJECTIVES FOR THE LABADIE SULFUR REDUCTION PROGRAM

Monitoring Parameter	Minimum Sampling Frequency	Minimum Data Accuracy	Sampling and Analytical Precision and Bias	Minimum Data Completeness
SO_2	1/sec	Span/One Point QC Check: ≤ ±10% Audits: ≤ ±15%	Precision: 90% CL CV ≤ 10% Bias: 95% CL ≤ ±10%	≥80% Per Quarter
Horizontal Wind Direction	1/sec	Alignment ≤ ± 5° Linearity (All Points) ≤ ± 3° (included in ≤ ± 5° above)	Not Applicable	≥90% Per Quarter, with four consecutive quarters of 90% recovery for an acceptable one-year data base.
Sigma Theta	1/sec	±5°	Not Applicable	
Horizontal Wind Speed	1/sec	±0.5 mph + 5% of observed	Not Applicable	
Vertical Wind Speed	1/sec	±0.5 mph	Not Applicable	
Air Temperature	1/sec	±0.5°C	Not Applicable	
Temperature Difference	1/sec	±0.1°C	Not Applicable	
Relative Humidity	1/sec	±7%	Not Applicable	
Solar Radiation	1/sec	±5%of mean observed interval	Not Applicable	
Barometric Pressure	1/sec	±3mb	Not Applicable	
Precipitation	1/sec	±10% of input volume	Not Applicable	

Note: Although the data quality objectives for the minimum data completeness for pollutant and meteorological parameters monitored have been set at the minimum required for PSD and modeling application programs, it has been the experience of Enviroplan Consulting that those data quality objectives are consistently met and typically exceed by following the QA/QC activities detailed in the QAPP.

Table A9: Summary of QA/QC for Field Monitoring Systems

Monitoring Instrument	Type of Check	Purpose of Check	Minimum Frequency [1]	Control Limit(s)
Data Logger	Calibration	Verifies linear calibration relationship between known test input signals and responses (in engineering units) across the measurement range for each initialized data channel.	Upon initial installation	
Automated Gaseous Pollutant Analyzers	Routine Instrument Checks and Preventive Maintenance	Verifies and documents operational status indications of analyzer & support equipment. Includes performance of routine preventive maintenance in accordance with instrument-specific needs and schedules.	Bi-Weekly	Monitor-specific criteria established for operating status indicators
	Automatic (2-Point) Calibration Check	Confirms analyzer response is within established control limits.	Daily	Zero drift ≤ ± 3 PPB over 24 hours Biweekly drift of ≤ ± 5 PPB; Span Point: ≤ ±10% of True
	Multi-point Calibration	Establishes and/or verifies linear calibration relationship between known test gas concentrations and analyzer responses across the measurement range.	Upon initial installation, Every 6 months thereafter	Zero Point: ≤ 5 PPB; Non-Zero Points: ≤ ±5% of True
	Level 1 Zero/Span Check	Data validation check; confirms analyzer calibration drift is within established control limits.	Bi-weekly, or if automatic cal check limits are exceeded	Zero drift ≤ ± 3 PPB over 24 hours Biweekly drift of ≤ ± 5 PPB; Span Point: ≤ ±10% of True
	One-Point QC Check	Used to assess the precision and bias of the data based on variability of responses over time.	Bi-weekly	≤ ±10% of True
	Independent Performance and Systems Audit	Assess accuracy of data produced by measurement system. Evaluate degree of conformance of field monitoring operations with QAPP and SOPs. Identify any problems.	Quarterly, each analyzer	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ± 1.5 ppb difference or ±15%

Table A9: Summary of QA/QC for Field Monitoring Systems

Monitoring Instrument	Type of Check	Purpose of Check	Minimum Frequency [1]	Control Limit(s)
Meteorological Monitors	Routine Instrument Checks and Preventive Maintenance	Verifies and documents operational status indications of analyzer & support equipment. Includes performance of routine preventive maintenance in accordance with instrument-specific needs and schedules.	Bi-Weekly	Monitor-specific criteria established for operating status indicators. General agreement of current data with prevailing meteorological conditions.
	Calibration and Extended Preventive Maintenance	Verifies acceptably accurate measurement system responses to known test conditions across the measurement range. Extended preventive maintenance includes, at minimum, replacement of bearings in all wind sensors.	Upon initial installation, Semi-annually thereafter	Refer to Data Accuracy Objectives stated for meteorological monitoring parameters in Table A8. Other performance criteria also apply (e.g., wind sensor starting torque, aspirator fan operation, etc.)
	Performance and Systems Audit	Verifies acceptably accurate measurement system responses to known test conditions across the measurement range.	Semi-annually	Refer to Data Accuracy Objectives stated for meteorological monitoring parameters in Table A8. Other performance criteria also apply (e.g., wind sensor starting torque, aspirator fan operation, etc.)

Notes to Table A9:

1. Additional checks may be performed to investigate or verify a fault condition and immediately following maintenance that could affect the calibration or performance of the monitor.

2. For functional monitors, maintenance or adjustment will always be preceded by an “As Found” (unadjusted) calibration or QC check to determine the monitor’s performance with respect to established measurement data quality indicators.

A4.3 Monitor Performance Specifications

All continuous, automated pollutant monitors operated in the monitoring program will incorporate the following general features:

- Incorporate microprocessor-based firmware or software that provides real-time indication of critical internal operating parameters.

- Internal pressure and temperature sensors for automatic compensation of measured pollutant concentrations for sample temperature and pressure.

- Provide automatic digital and visual alarm indications if diagnostic limits for internal operating parameters are exceeded.

- Provide an electronic analog output signal that is linearly proportionate to the instantaneous measured concentration value.

- Incorporate internal digital data acquisition and non-volatile internal electronic memory that allow the monitor to log and retain at least 30 days of historical data for internal operating parameters and calibration settings data.

- Stored data shall be retrievable through a serial and/or Ethernet port, or from a front panel display, allowing operators to perform predictive diagnostics and enhanced data analysis by tracking parameter trends.

- Provide PC-compatible communications software for remote interrogation and download of stored data via an integral communications port using standard communications protocol and user-supplied modem.

- In the interest of standardization, each monitor operated at the monitoring sites that measures a specific pollutant or meteorological parameter shall be of the same make and model.

The specific models of monitors and support equipment selected for use in the monitoring program can be found in Sections A4.3.1 through A4.3.2.

A4.3.1 Sulfur Dioxide (SO_2) Monitors

Ambient concentrations of sulfur dioxide (SO_2) will be continuously measured using Teledyne Advanced Pollution Instrumentation (TAPI) Model T100 UV Fluorescence automated SO_2 monitors that are designated as Equivalent Method Number EQSA-0495-100 by the US EPA in accordance with 40CFR Part 53, Subparts A and C. The SO_2 monitors will be operated and maintained in accordance with all corresponding EPA equivalent method requirements. The SO_2 monitors will be operated in the 0 to 500 ppb full scale measurement range with temperature and pressure compensation features activated and an internal averaging time setting of 30 seconds. SO_2 measurement data will be recorded by the digital acquisition system as one-minute, five-minute and hourly block-averaged concentrations measured in parts per billion (ppb).

The TAPI Model T100 UV Fluorescence SO_2 Analyzer is a microprocessor-controlled analyzer that determines the concentration of sulfur dioxide (SO_2), in a sample gas drawn through the instrument's sample chamber where it is exposed to ultraviolet light, which causes any SO_2 present to fluoresce. The instrument measures the amount of fluorescence to determine the amount of SO_2 present in the sample gas. Stability is achieved with the use of an optical shutter to compensate for sensor drift and a reference detector to correct for changes in UV lamp intensity. Additionally an advanced optical design combined with a special scrubber, called a "kicker" that removes hydrocarbons (which fluoresces similarly to SO_2), thereby preventing inaccuracies due to interferants.

The manufacturer's published specifications for the TAPI Model T100 UV Fluorescence SO_2 Analyzer are as follows:

- lower detectable limit (LDL) of 0.4 ppb
- zero drift specified as less than 0.5 ppb/24 hours
- span drift specified as less than 0.5 percent of full scale/24 hours
- zero noise less than 0.2 ppb
- span noise less than 0.5 percent of readings above 50 ppb
- linearity is 1 percent of full scale
- precision is 0.5 percent of readings above 50 ppb

All TAPI "T"- series monitoring instruments offer an advanced color display, capacitive touch screen, intuitive user interface, flexible input/output (I/0) capabilities and built-in monitoring and recording of critical operating parameters in support of instrument trouble-shooting and problem diagnosis. All instrument set up, control and access to stored data and diagnostic information is available through the front panel and via the RS232, Ethernet, and USB com ports either locally or by remote connection using the included APIcom™ software.

Performance specifications are summarized in Table B2. The performance specifications were obtained directly from the manufacturers' publicly available product brochures.

A4.3.2 <u>Meteorological Monitoring</u>

Meteorological data will be collected at the Valley Site and the Tall Tower Site using meteorological monitoring equipment that meets the technical and performance specifications contained in the publication "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005, February 2000). Table A4 lists the meteorological parameters that will be monitored at the monitoring sites. Performance specifications are summarized in Table B2.

A5. TRAINING AND CERTIFICATIONS

Early in the procurement phase of the project, Enviroplan Consulting will conduct a recruiting campaign, select and hire a qualified individual for the position of local field operator for the monitoring stations. The field operator will have a background in air quality monitoring, electronics or instrumentation. The field operator will then complete an extensive training program conducted by Enviroplan Consulting. The training program will be specific to the air monitoring program requirements and monitoring instruments. The equipment designated for supply for the monitoring program will be utilized in the training program.

Our local field operator will perform all routine, day-to-day operation and maintenance services for the monitoring stations in accordance with the regulatory guidelines and requirements applicable to the monitoring program. The field operator will be supported in this work by the experienced staff of Enviroplan Consulting's Monitoring Division.

Site specific training for this project covers activities performed in the field including record keeping practices. Enviroplan Field Operators for this project will receive training on the operation and maintenance of the SO_2 analyzers, meteorological monitors, and related equipment. Training will be conducted by the Enviroplan Project Manager.

All personnel working on any element of this project have had their qualifications reviewed and have been determined to have sufficient experience and knowledge in both meteorological monitoring and data processing. Personnel assigned to ambient air monitoring activities are expected to have met the educational, work experience, responsibility, personal attributes, and training requirements for their positions. Appropriate training shall be available to all employees supporting the Ambient Air Quality Monitoring Program, commensurate with their duties. Ambient air monitoring professionals with several years of experience will have responsibility for conducting the most significant quality control and quality assurance activities on site. Training will be documented in Standard Operating Procedures.

A6. DOCUMENTS AND RECORDS

Documentation and records for this project include equipment calibration and maintenance records, documentation of quality control/quality assurance activities, routine monitoring data, corrective action and resolution forms, any QAPP revision documentation, and records of Enviroplan field activities (e.g., site checklists). All hard-copy documentation is stored at the Enviroplan Wayne, NJ office and will be retained for a period of at least five years from the completion of the project. Electronic data are stored indefinitely on various media with full project backups. Electronic data collected for this project and data transferred to electronic format will be provided to Ameren via CD-ROM or e-mail.

The quarterly data summaries will be prepared by Enviroplan in accordance with the format described in Appendix 8 and provided to Ameren and MDNR within 60 days after the completion of each calendar quarter.

A6.1 Equipment Calibration and Maintenance Records

Field calibration of the continuous gas analyzers and particulate monitors is documented on appropriate Field Calibration Data Sheets or equivalent. Calibration of the sensors deployed at the meteorological station was conducted at the manufacturer's facility. Acceptance testing of the sensors will be done upon delivery and start up calibration will be completed upon installation. The project Data Manager maintains records of these calibrations. Paper records will be stored for at least five years and are also entered into the Enviroplan database. Examples of the forms utilized in the monitoring program can be found in Appendix 8.

A6.2 Records of Field Activities

The Field Operator(s) document all field activities on appropriate forms and also in the site logbook maintained or electronic station log maintained at each site. Pollutant analyzer calibrations and quality control checks including a Level 1 zero/span check are documented on SO_2 Analyzer Calibration Form. Routine gaseous pollutant analyzer checks are documented on the SO_2 Analyzer System Routine Check. Details of instrument maintenance and repair are recorded on Instrument Maintenance Log. After each site visit, the Operator(s) completes a Meteorological System Site Checklist to document the completion of routine operational procedures and checks related to meteorological equipment. Copies of all Project forms can be found in Appendix 8. Paper records will be stored for at least five years and are also entered into the Enviroplan database.

A6.3 Monitoring Data

Data from the monitoring stations is collected using a digital datalogger. The monitoring data acquisition system is interfaced with the station gas analyzers via Ethernet and analog connections and programmed to initiate daily automated zero/span quality assurance checks of the continuous gas analyzers. Ambient air and meteorological data is downloaded on a daily basis. The station operator, data manager, and station auditor will generate written or typed records. These records are archived for a minimum of five years at the Enviroplan Consulting main office.

SECTION B: MEASUREMENT AND DATA ACQUISITION

B1. SAMPLING PROCESS DESIGN

Ameren Corporation (Ameren) operates the Ameren Labadie Energy Center, an electrical power generating station, located at 226 Labadie Power Plant Road in Labadie, Missouri. The generating station is located in Franklin County approximately 56 km west of St. Louis, Missouri. Ameren plans to assess compliance with the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The proposed project is referred to as the Labadie Sulfur Reduction Project.

Ameren plans to conduct SO_2 and meteorological monitoring at monitoring sites in the vicinity of the Labadie Energy Center in a manner and with instrumentation approved by the MDNR APCP.

Table B1 lists the sampling equipment and design for the parameters measured in the program including the make and model of the equipment; the measurement method, frequency, range, and reporting units; and the sampling average. Table B2 presents a summary of the monitoring instrument performance specifications. The tables and figures in Section B1 can also be found in Appendix 2.

Table B1: Sampling Equipment and Design for the Labadie Sulfur Reduction Project			
Parameter (Manufacturer/Model)	**Measurement Method**	**Measurement Frequency, Range and Units**	**Sample Averaging**
Ambient Air Quality Measurements			
Sulfur Dioxide (Teledyne API Model T100)	Ultraviolet (UV) fluorescence spectroscopy	Continuous 0 to 500 ppb	1 second samples averaged on an one-minute, five-minute, and hourly basis
Meteorological Measurements			
Horizontal Wind Speed (Climatronics F-460, 100075)	Three-Cup Anemometer, LED Photo Chopper	Continuous 0.5 to 100.0 mph	1 second samples averaged on an one-minute, five-minute, and hourly basis
Vertical Wind Speed (Climatronics 102236)	Gill Propeller, LED Photo Chopper	Continuous -10 to +10 mph	
Standard Deviation of Vertical Wind Speed (σ_W)	DAS Calculated	Continuous 0 to 20 mph	
Horizontal Wind Direction (Climatronics F-460, 100076)	Lightweight Vane, Low Torque Potentiometer	Continuous 0 to 360^o	
Standard Deviation of Horizontal Wind Direction (σ_θ)	DAS Calculated	Continuous 0 to 104^o	
Ambient Temperature (Climatronics 100093)	Dual-Element Thermistor in Stainless Steel Case, Housed in a TS-10 Motor Aspirated Shield	Continuous -25^o to 125^{o}F	
Temperature Difference	DAS Calculated (Upper – Lower)	Continuous -22^o to +22^{o}F	
Solar Radiation (Eppley 8-48 "Black & White")	Solar Pyranometer	Continuous 0 to 1,500 W/m^2	
Relative Humidity (Climatronics 102278)	Polymer, Thin Film Capacitor	Continuous 0 to 100%	
Barometric Pressure (Climatronics 102263)	Capacitive Transducer	Continuous 800 to 1100 mb	
Precipitation (Climatronics 100097)	Tipping Bucket-Type Gage with 8" Dia. collection and thermostatically-controlled heater	Continuous 0.00 to Unlimited Inches of Total Hourly Precipitation	1 second samples totalized on an one-minute, five-minute, and hourly basis
Miscellaneous Measurements			
Shelter Temperature (Comet TO 218)	Temperature Transmitter	Continuous 0^0 to 50^{o}C	1 second samples averaged on an one-minute, five-minute, and hourly basis
Power Surge Protection Status (Emerson Model IM120S160)	AC Surge Protector	Continuous (Digital)	Sampled once per second, status included in one-minute, five-minute, and hourly data tables
AC Line Power Status (White Rodgers SPS-1412)	External Plug-In Power Supply	Continuous (Digital)	

TABLE B2: Summary of Monitoring Instrument Performance Specifications for the Labadie Sulfur Reduction Project	
Parameter/Equipment	**Performance Specification**
Sulfur Dioxide (SO_2) / Teledyne-Advanced Pollution Instruments Model T100 Pulsed Fluorescent Analyzer	Zero Drift: < 0.5 ppb over 24 Hours Span Drift: < 0.5% of Full Scale over 24 Hours Measurement Linearity: 1% of Full Scale Precision: 0.5% of reading above 50 ppb Zero Noise: 0.2 ppb RMS Span Noise: < 0.5% of reading (RMS) above 50 ppb Lower Detection Limit: 0.4 ppb Response Time: <100 Seconds (0 to 95%) Lag Time: 20 Seconds Operating temperature range: 5º – 40ºC (Acceptable U.S. EPA Equivalent Method range for air quality monitoring)
Horizontal Wind Speed / Climatronics Model 100075 (F-460) 3-cup Anemometer	Range: 0.0 - 100.0 mph (0.0 - 50 m/s) Threshold: 0.5 mph (0.22 m/s) Distance constant: <1.5m (4.9 ft.) Accuracy: ± 0.15 mph (± 0.07 m/s) or ± 1.0% of True air speed (whichever is greater) Resolution: 0.1 m/s; 0.1 mph)
Vertical Wind Speed / Climatronics Model 102236-G1 Gill Propeller Anemometer (with Photo Chopper and #08274 Expanded Polystyrene Propeller)	Range: -70 to 70 mph (-31 to 31 m/s) Threshold: 0.3 mph (0.15 m/s) Distance constant: 1.0m (3.2 ft.) Accuracy: ± 1.0% Resolution: 0.1 m/s (0.1 mph)
Wind Direction / Climatronics Model 10076 (F-460) Wind Vane	Range: 0º - 360º Threshold: 0.5 mph (0.22 m/s) Distance constant: <1.0m (3.0 ft.) Accuracy: ± 2º Damping ratio: >0.4 at 10° initial angle of attack Resolution: 1º
Air Temperature and Temperature Difference / Climatronics Model 10093 Temperature Probe housed in Climatronics Model 100325 (TS-10) motor-aspirated radiation shield Dual-Element (linearized) solid-state thermistor (matched with Temperature Difference probe).	Temperature Range: -25º to 125ºF (-30 to 50ºC) Temperature Difference Range: -20º to +20ºF Accuracy: ±0.27°F (±0.15°C) over full range Time constant: 3.6 seconds Linearity: ±0.29°f (±0.16°C) Shield Aspiration rate: 10 ft./sec (3 m/s) at sensor location Shield effectiveness: under radiation intensities of 1,100 w/m² (1.6 cal./cm²/min) measurement errors due to radiation will not exceed 0.2°F (0.1°C)

TABLE B2: Summary of Monitoring Instrument Performance Specifications for the Labadie Sulfur Reduction Project	
Parameter/Equipment	**Performance Specification**
Relative Humidity / Climatronics Model 102273 Thin-Film Capacitive Probe with Temperature Compensation housed in Climatronics Model 100325 motor-aspirated radiation shield Temperature compensation maintains accuracy even at 100% RH (saturation) conditions. Long Term Stability (+/-1% over 12 months)	Range: 0 to 100% Max error ± 1% Time constant: < 10 seconds Repeatability: ± 0.3% Operating temperature range -40° to 60°C Aspiration rate: 500 cfm Shield effectiveness: under radiation intensities of 1100 w/m²(1.6 cal./cm²/min) measurement errors due to radiation will not exceed 0.2°F (0.1°C)
Barometric Pressure / Climatronics Model 102663-1 Barometric Pressure Sensor Long Term Stability: calibration drift < ±0.25% full scale over 6 months.	Range: 800mb to 1,100mb (23.62 to 32.48'Hg) Temperature-compensated response Max error: < ±0.3mb (< ± 0.01 inHg) Time delay: 1ms (max. 17ms) Operating temperature range -20° to 80°C
Solar Radiation / Eppley Model 8-48 ("Black & White") Solar Pyranometer (ISO First-Class Pyranometer)	Detector: Differential Thermopile with built-in temperature compensation Glass Hemisphere: Precision-Ground Schott WG295 Spectral range: 285 to 2.800 milli-microns Sensitivity (approximate): 11 µV/W/m² Cosine Response: ±2% from normalization, 0º-70º zenith angle and ±5% from normalization, 70º-80º zenith angle Response time: 5 seconds Stability: < 1% per year Temperature dependence of sensitivity ≤ ±1.5%, -4 ºF to +104 ºF Operating temperature range: -40 °C to +80 °C Field of view: 180°
Precipitation / Climatronics Corp. Model 100097-1 8" Tipping-Bucket Precipitation Gauge with Wind Screen and Thermostatically-Controlled Internal Heater to Measure Frozen Precipitation	Accuracy: ±1% for rain rates of 1 to 3 in/hr.; ±3% for rain rates of 0 to 6 in/hr. Output: Switch Closure (once per bucket tip) Measurement Resolution: 0.01" (1 bucket tip)

B1.1 Monitoring Site Selection

The objective of the Labadie Sulfur Reduction Project is to assess compliance with the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The fully quality-assured, validated monitoring data will be reported to the Missouri Department of Natural Resources Air Pollution Control Program (MDNR APCP). In keeping with this objective, the monitors need to be located close to the Labadie Energy Center while avoiding direct exposure to process areas and potential emission points. The monitor locations should additionally provide comprehensive spatial coverage with respect to the Labadie Energy Center so as to obtain concurrent measurements at locations that are upwind and downwind of the generating station under varying meteorological conditions.

Monitoring for SO_2 will be conducted at two site locations (i.e. Northwest Site and Valley Site) and meteorological parameters will be measured on a 10 m tower at the Valley Site and also on a tall tower located at the Tall Tower Site. The selection of monitoring sites and associated parameters is based upon the objectives of the monitoring program and previous meetings and communications between Ameren and the MDNR APCP. Table B3 provides a summary of the monitoring site locations and parameters to be monitored at each location including the site designation and geographical location, the parameters measured at each site and the height at which the measurement is made. Figure B1 provides an aerial view of the Labadie Energy Center and the surrounding environs. Figure B2 presents an aerial view of the Labadie Energy Center and the site locations. Section B1.6 provides a detailed description of each site along with photographs characterizing the sampling locations.

Potential site locations were evaluated with respect to relevant air quality monitor siting and exposure criteria as published in 40 CFR Part 58, Appendix A as well as practical considerations that include site availability, accessibility, security and proximity to existing utility services.

Additionally, locations for two meteorological monitoring sites were evaluated with respect to the guidance contained in the "Quality Assurance Handbook for Air Pollution Measurement System: Volume IV- Meteorological Measurements Version 2.0 (Final)" (*EPA-454/B-08-002*, March 2008). The following is a prioritized list of siting objectives with respect to the proposed monitoring stations for the monitoring network:

B1.1.1 <u>Prioritized Siting Criteria for Air Quality Monitors</u>

1. Availability of land, accessibility to site, availability of utility services, and security of monitors and operating personnel.

2. Geographic spacing of sites relative to the refinery for monitoring upwind and downwind concentrations.

3. Probe or sampler inlet should be 2 to 5 m (6.56 to 16.4 ft.) height above ground and have unrestricted airflow 270 degrees around the sample inlet probe or 180 degrees if the probe is on the side of a building.

4. Probe or sampler inlet should be >20 m (~66 ft.) from the dripline of tree(s).

5. SO_2 probes should be >1 m away from supporting structures, walls and parapets.

6. Distance from sampler probe to obstacle, such as a building, should be at least twice the height the obstacle protrudes above the sampler, probe, or monitoring path.

7. All probes and samplers should be away from minor sources, such as furnace or incineration flues. The separation distance is dependent on the height of the minor source’s emission point (such as a flue), the type of fuel or waste burned, and the quality of the fuel (sulfur, ash, or lead content). This criterion is designed to avoid undue influences from minor sources.

B1.1.2 <u>Prioritized Siting Criteria for Meteorological Monitors</u>

1. Availability of land, accessibility to site, availability of utility services, and security of monitors and operating personnel.

2. Geographic location relative to Labadie Energy Center to obtain meteorological data representative of the area of interest.

3. All meteorological monitors should be securely mounted on 10m towers that will not twist, rotate or sway. The towers should be of open grid and tilt-over/fold down design to facilitate accessing the monitors for calibrations and maintenance. The tower height can be greater than 10m based on the height of the source, points of impact, the use of the data, and any site limitations.

4. Wind sensors should be:

   - Mounted on a boom at least two tower widths away from the tower side or one tower width above the tower top.
   - Located over level, open ground and horizontally spaced away from obstructions by a distance of at least 5 times (preferably 10 times) the obstruction height

- If wind sensors are located on a building roof, their height should be 1.5 times the building height.

5. Temperature and relative humidity sensors should be:

- Mounted at a height of 10m (other heights may be used, depending on monitoring program objectives and requirements) over open, level ground that is covered in grass or dirt extending a minimum radius of 4.5 meters from the sensor.
- Mounted in motor-aspirated radiation shields that minimize heating effects of solar radiation and insolation.
- Mounted on a boom that extends one tower width away from the tower side.
- Located away from obstructions by a distance of at least 4 times the obstruction height.
- Located at least 30 meters away from large paved areas, slopes, ridges, and valleys.

B1.2 Topographical Description

Figure B3 provides a sectional topographic map of the terrain within a 4 Km radius of the Labadie Energy Center and includes depiction of monitoring site locations. Figures B4, B5, and B6 provide sectional topographic maps of the terrain surrounding the individual monitoring sites. The Labadie Energy Center lies in Jefferson County, Missouri along the Missouri River on a broad, level flood plain at an elevation of 490 feet (~149m) above mean sea level (MSL). The broad flood plain consisting of farm land ends at its boundaries at a steep rise to a topography that varies from gently rolling to broken and ridgy along a northwest to southeast line, the strong rolling with ridges and hills comprising of wooded and heavily wooded areas to the east of the northwest to southeast line and the areas to the west gently rolling with mixed timber growth and farm land. Jefferson County and neighboring St. Louis County is at the start of the Ozark Mountains to the south. The Labadie Energy Center is located approximately 55 kilometers west from the center of the St. Louis, Missouri.

B1.3 Land Use Description

Land use within that radius of the refinery is a rural with small towns and scattered residential housing. The towns of Labadie, Gray Summit, St. Albans, and Augusta, all in Missouri, are within 10 km of the Labadie Energy Center. Figure B1 presents aerial views of the Labadie Energy Center and adjacent areas.

Table B3: Monitoring Sites and Parameters for the Labadie Sulfur Reduction Project

Site Designation and Location (UTM Coordinates are NAD 83 Datum, Zone 17)	Monitored Parameters	Probe Level (meters)
Northwest Site		
Latitude: 38º 34’ 54.48” N; Longitude: 90º 51’ 55.90” W UTM: 4272530.402m Northing; 685920.407m Easting	SO_2	3
Valley Site		
Latitude: 38º 34’ 21.08” N; Longitude: 90º 47’ 48.88”W UTM: 4271641.912m Northing; 691922.523m Easting	Horizontal Wind Speed	10
	Vertical Wind Speed	10
	Standard Deviation of Vertical Wind Speed	10
	Horizontal Wind Direction	10
	Sigma Theta	10
	Ambient Air Temperature	2
	Air Temperature	10
	Temperature Difference	10-2
	Relative Humidity	2
	Barometric Pressure	1.5
	Precipitation	1.0
	Solar Radiation	2
Tall Tower Site		
Latitude: 38º 33’ 43.15” N; Longitude: 90º 46’ 58.82”W UTM: 4270501.750m Northing; 693162.265m	Horizontal Wind Speed	30, 65
	Vertical Wind Speed	30, 65
	Standard Deviation of Vertical Wind Speed	30, 65
	Horizontal Wind Direction	30, 65
	Sigma Theta	30, 65
	Air Temperature	30,65
	Temperature Difference	65-30

Figure B1: Ameren Labadie Energy Center and Geographic Environs

Figure B2: Aerial View of Ameren Labadie Energy Center with Monitoring Site Locations

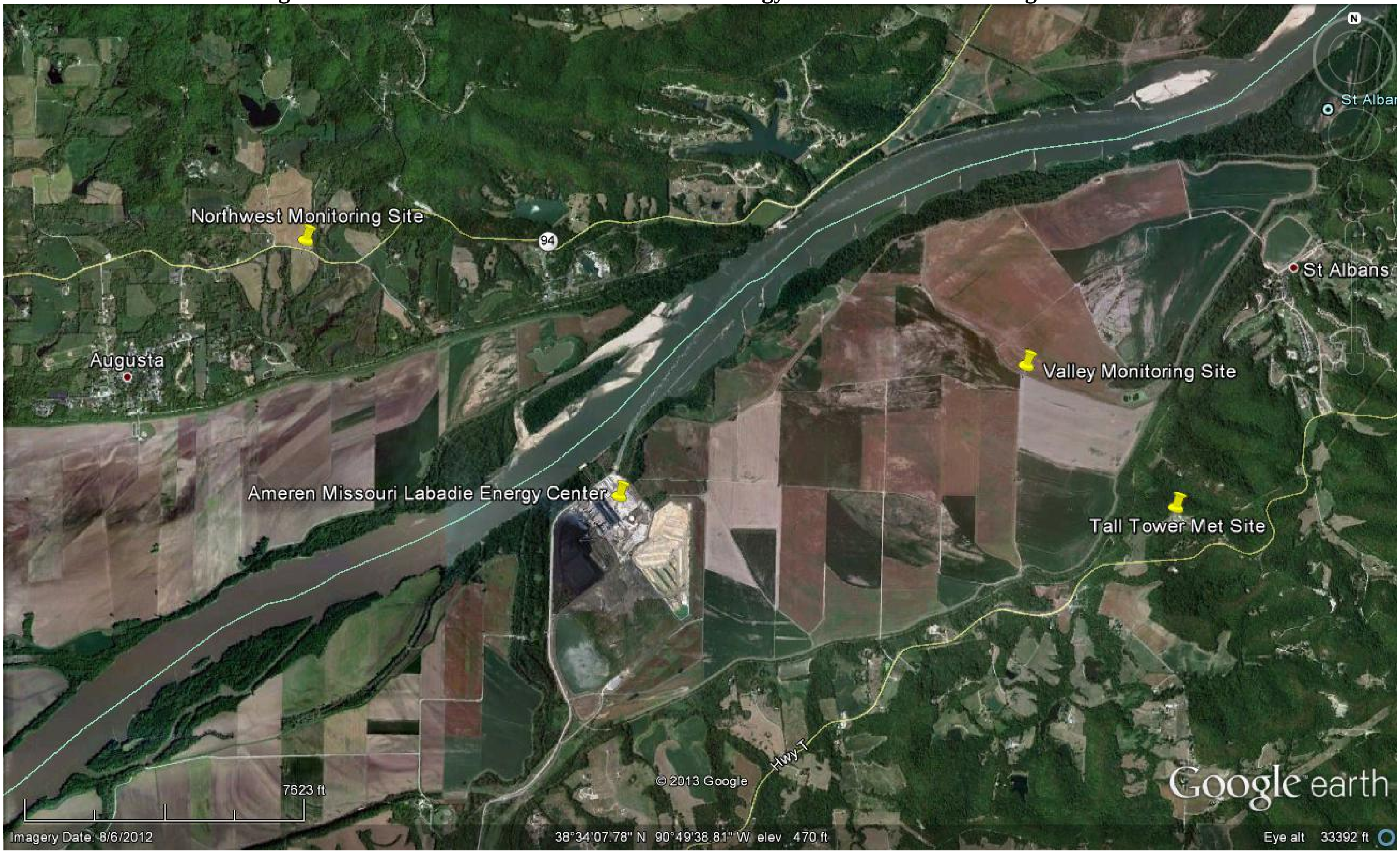


Figure B3: Topographic View of Area within 4 Km of Labadie Energy Center

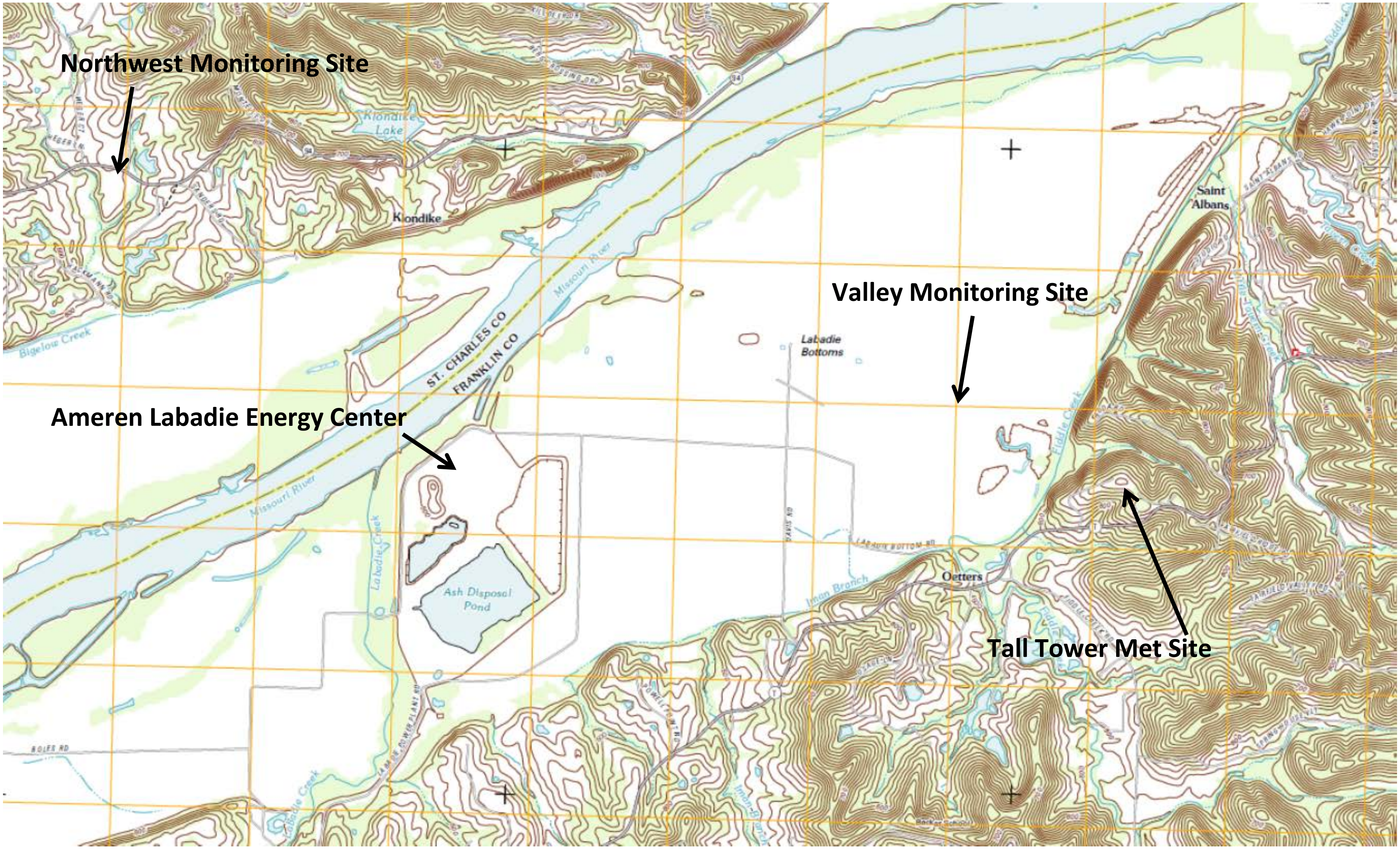


Figure B4: Topographic View of Area Surrounding the Northwest Monitoring Site

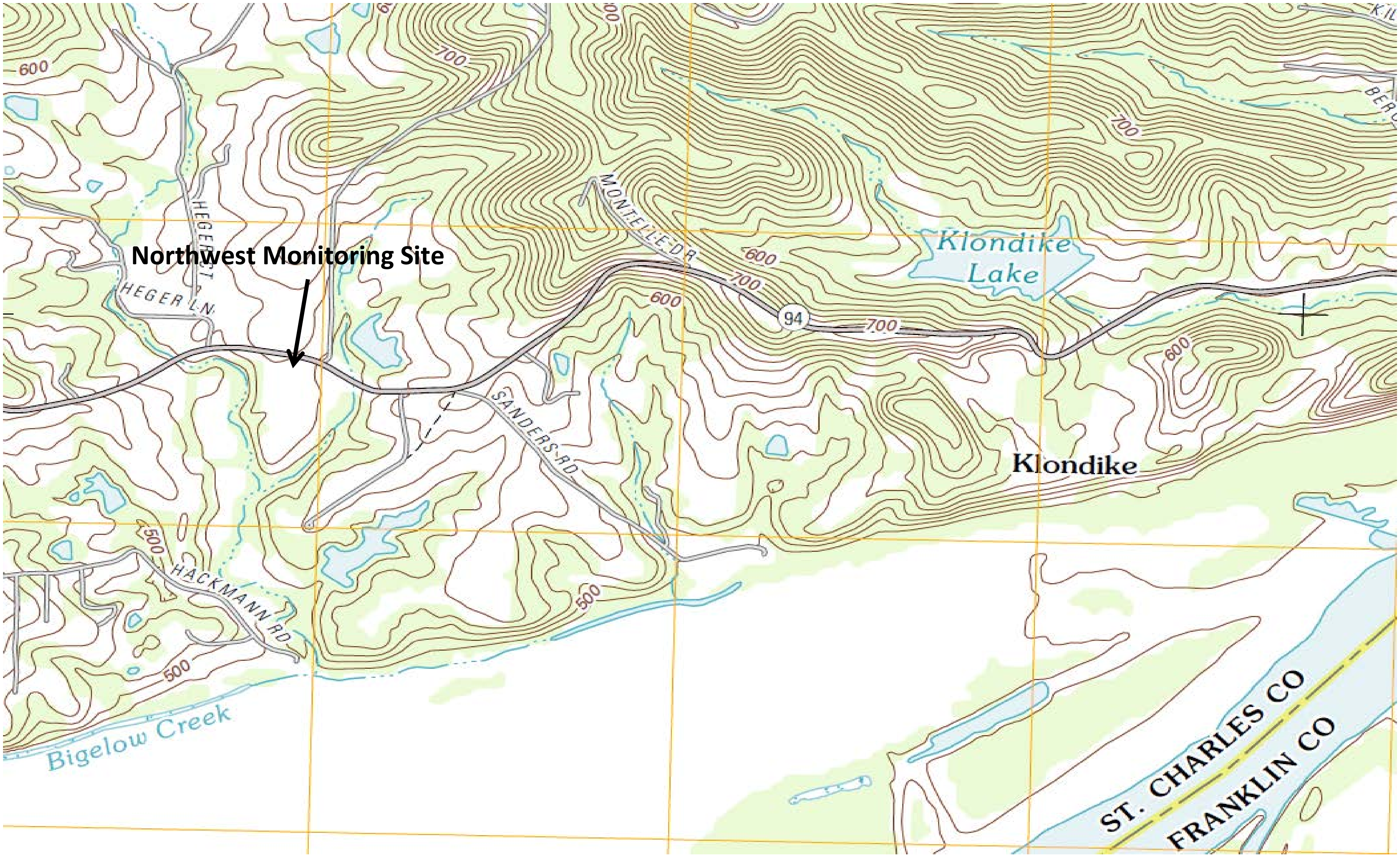


Figure B5: Topographic View of Area Surrounding the Valley Monitoring Site

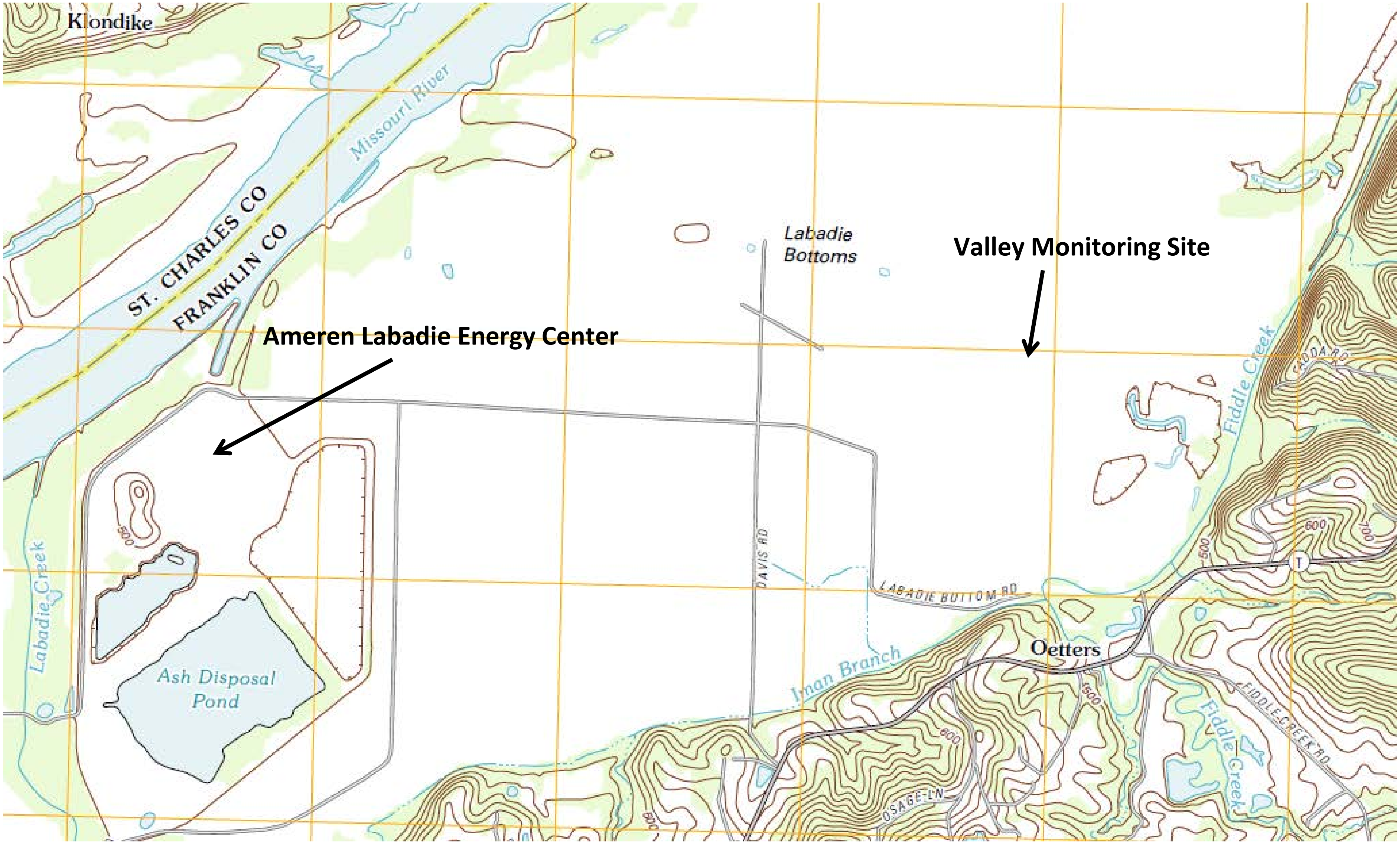
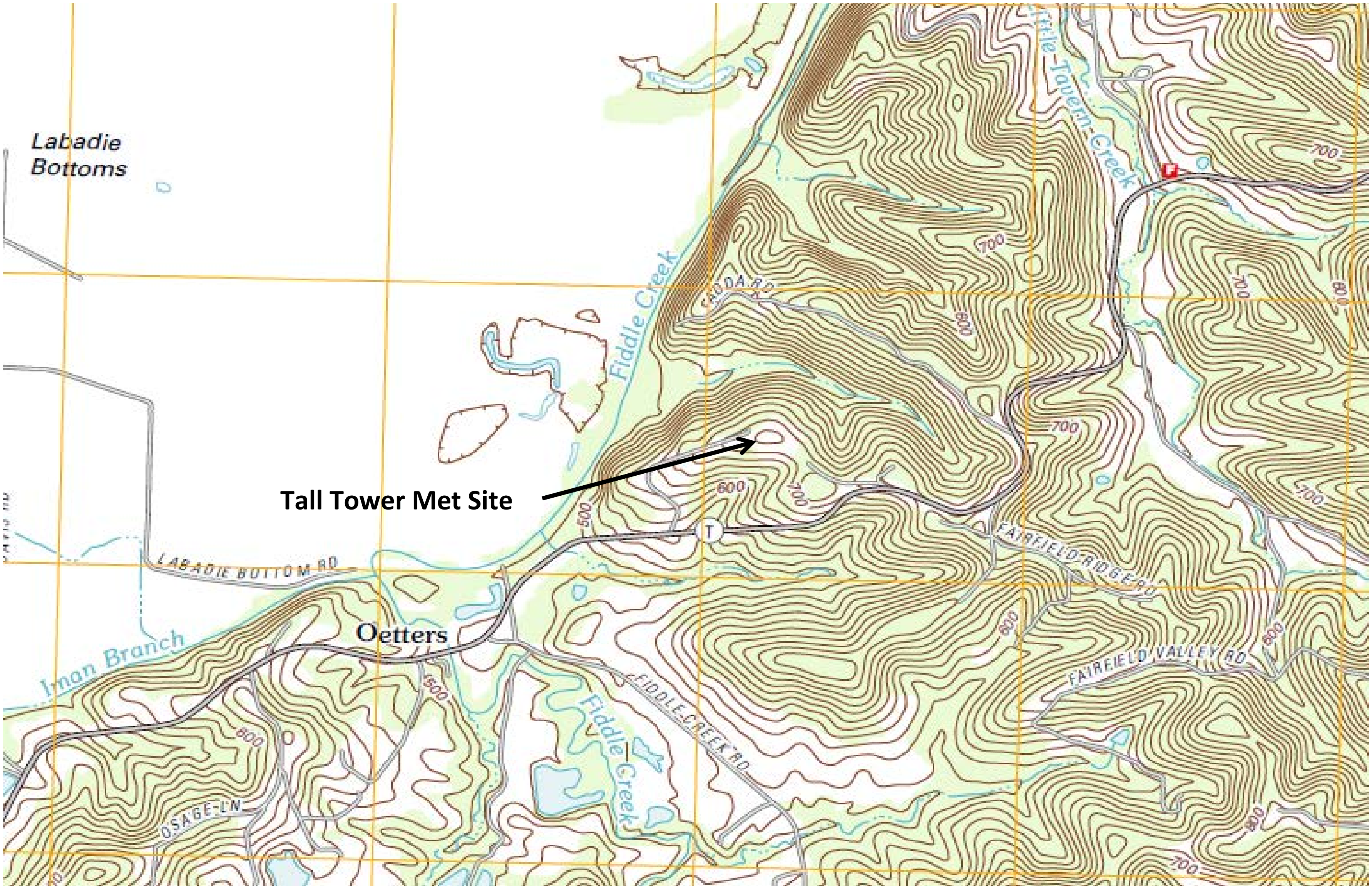


Figure B6: Topographic View of Area Surrounding the Tall Tower Monitoring Site



B1.4 Climatological Description

The closest first-order National Weather Service (NWS) station is the St. Louis Lambert International Airport, NWS Station KSTL. This station is located about 45 km to the east-northeast of the Labadie Energy Center and provides the most comprehensive record of climatologic data for the region that is considered to be representative of conditions in the site area.

St. Louis lies in the transitional zone between the humid continental climate type and the humid subtropical climate type (Köppen Dfa and Cfa, respectively), with neither large mountains nor large bodies of water to moderate its temperature. It is subject to both cold Arctic air and hot, humid tropical air from the Gulf of Mexico. The city has four distinct seasons. Spring is the wettest season and produces severe weather ranging from tornadoes to winter storms. Summers are hot and humid; temperatures of 90 °F (32 °C) or higher occur 35 to 40 days a year, while days of 100 °F (38 °C) or higher average less than five yearly.

Fall is mild with lower humidity and can produce intermittent bouts of heavy rainfall with the first snow usually falling before late mid-November. Winters can be cold and snowy with temperatures frequently below freezing. Winter storm systems, such as Alberta clippers and Panhandle hooks, can bring days of heavy freezing rain, ice pellets, and snowfall.

The NWS describes the climate surrounding the KSTL station as follows:

> St. Louis is located at the confluence of the Mississippi and Missouri Rivers, and near the geographical center of the US. Its position in the middle latitudes allows the area to be affected by warm moist air that originates in the Gulf of Mexico, as well as cold air masses that originate in Canada. The alternate invasion of these air masses produces a wide variety of weather conditions, and allows the region to enjoy a true four-season climate.
>
> During the summer months, air originating from the Gulf of Mexico tends to dominate the area, producing warm and humid conditions. Since 1870, records indicate that temperatures of 90 degrees or higher occur on about 35-40 days per year. Extremely hot days (100 degrees or more) are expected on no more than five days per year.
>
> Winters are brisk and stimulating, but prolonged periods of extremely cold weather are rare. Records show that temperatures drop to zero or below averages of 2 or 3 days per year, and temperatures as cold as 32 degrees or lower occur less than 25 days in most years. Snowfall has averaged a little over 18 inches per winter season, and snowfall of an inch or less is received on 5 to 10 days in most years.
>
> Normal annual precipitation for St. Louis is a little less than 34 inches. The three winter months are the driest, with an average total of about 6 inches of

precipitation. The spring months of March through May are normally the wettest with normal total rainfall of just under 10.5 inches. It is not unusual to have extended dry periods of one to two weeks during the growing season.

Thunderstorms normally occur on between 40 and 50 days per year. During any year, there are usually a few of these thunderstorms that are severe, and produce large hail and damaging winds. Tornadoes have produced extensive damage and loss of life in the St. Louis area.

Figure B7 presents an annual climate graph of temperature and precipitation for 2012 for the KSTL NWS Station. Figures B8, B9, B10, and B11 presents select monthly wind rose plots from 1961 to 2002.

Figure B7: Annual Climate Graph for 2012 for the St. Louis NWS Station

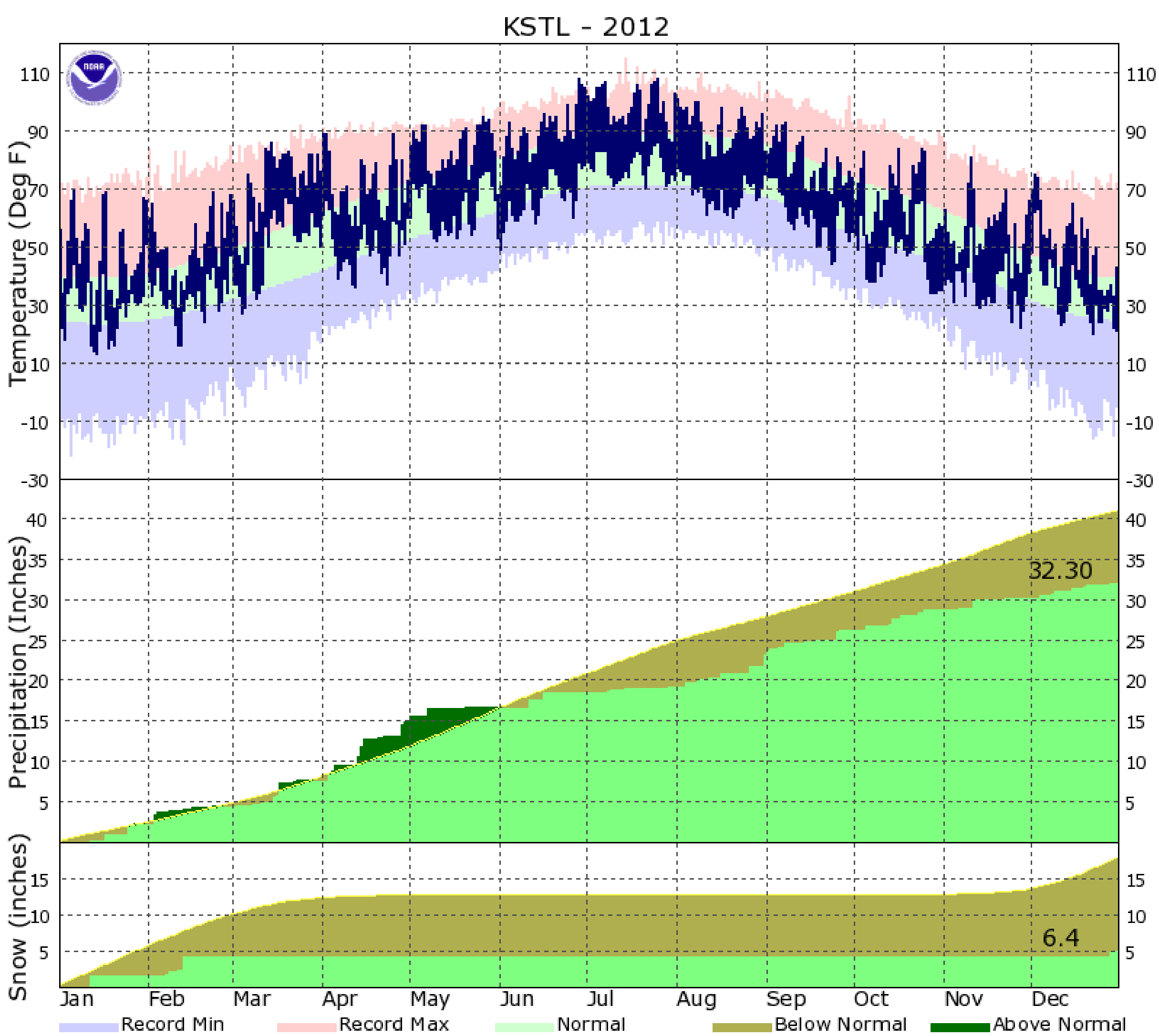


Figure B8: Month of March Wind Rose Plots from 1961 to 2002

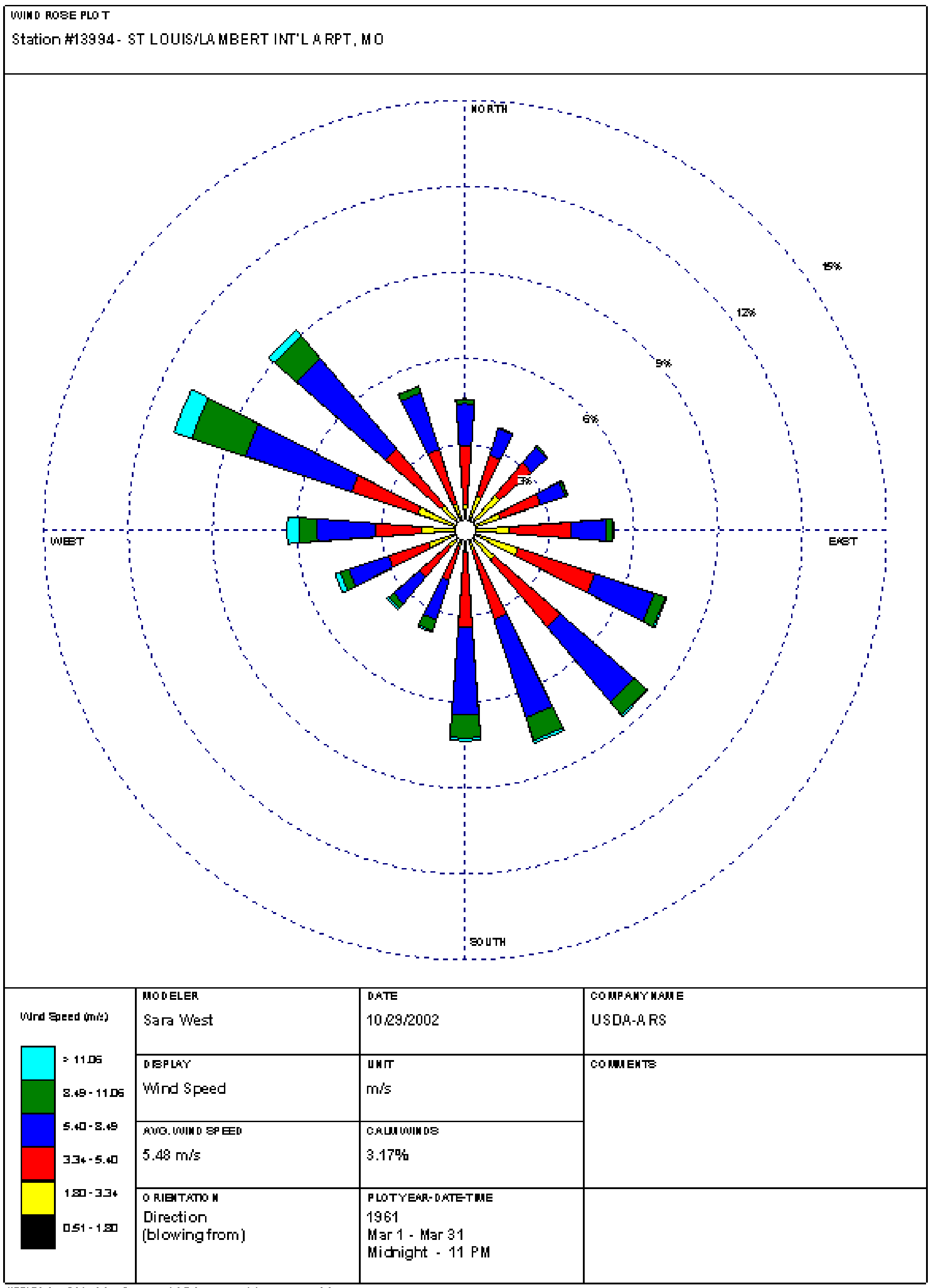


Figure B9: Month of June Wind Rose Plots from 1961 to 2002

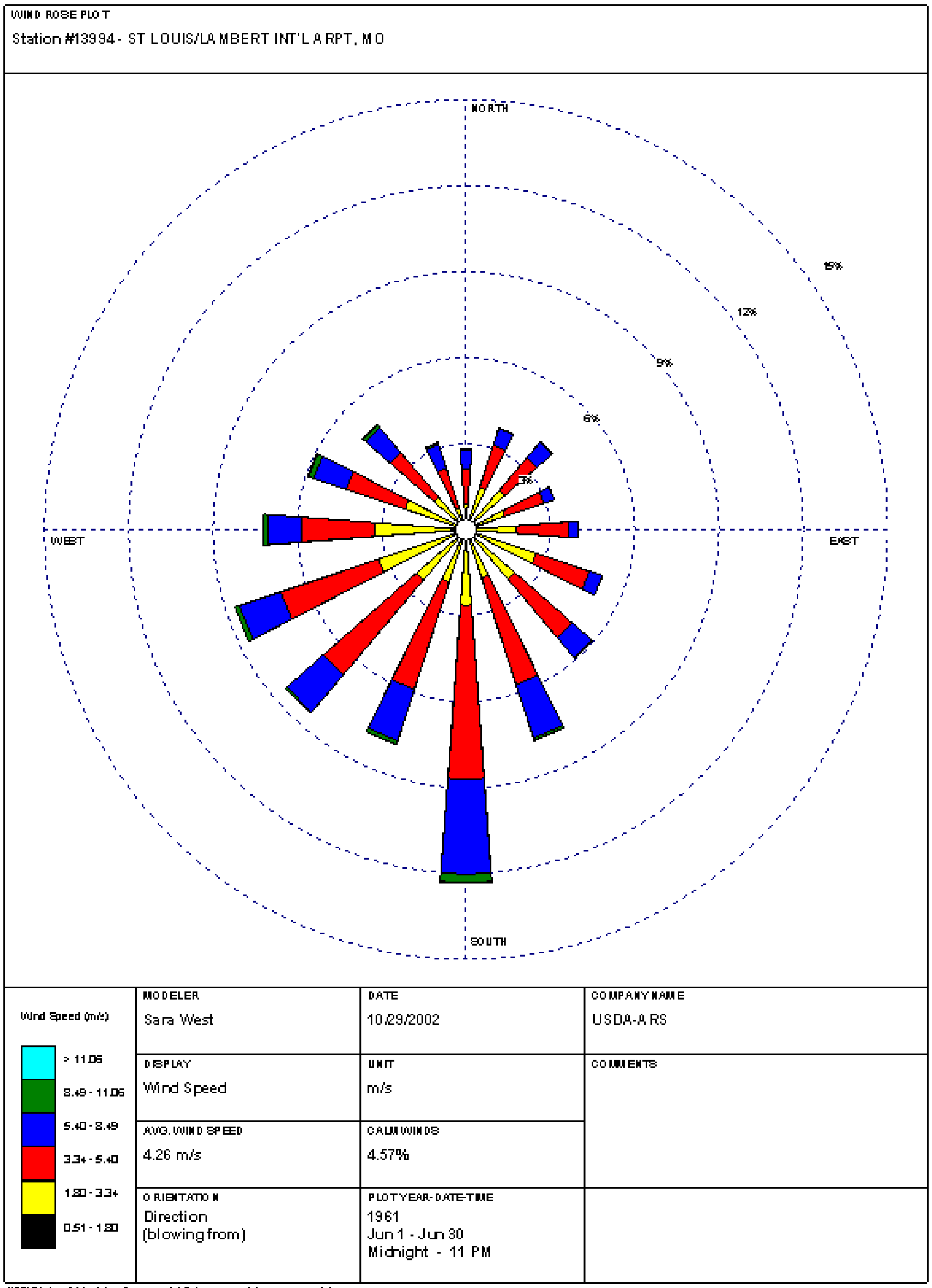


Figure B10: Month of September Wind Rose Plots from 1961 to 2002

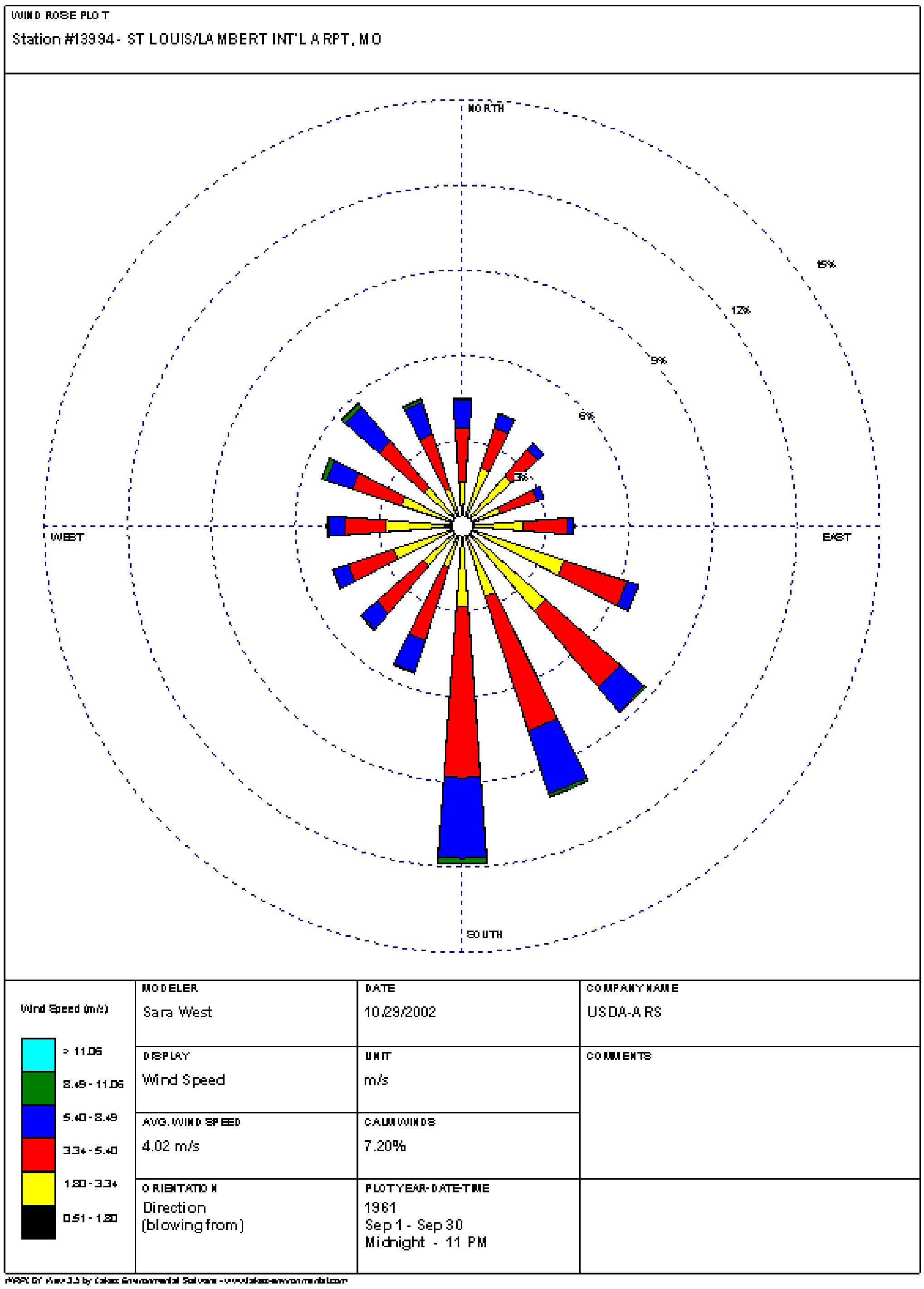
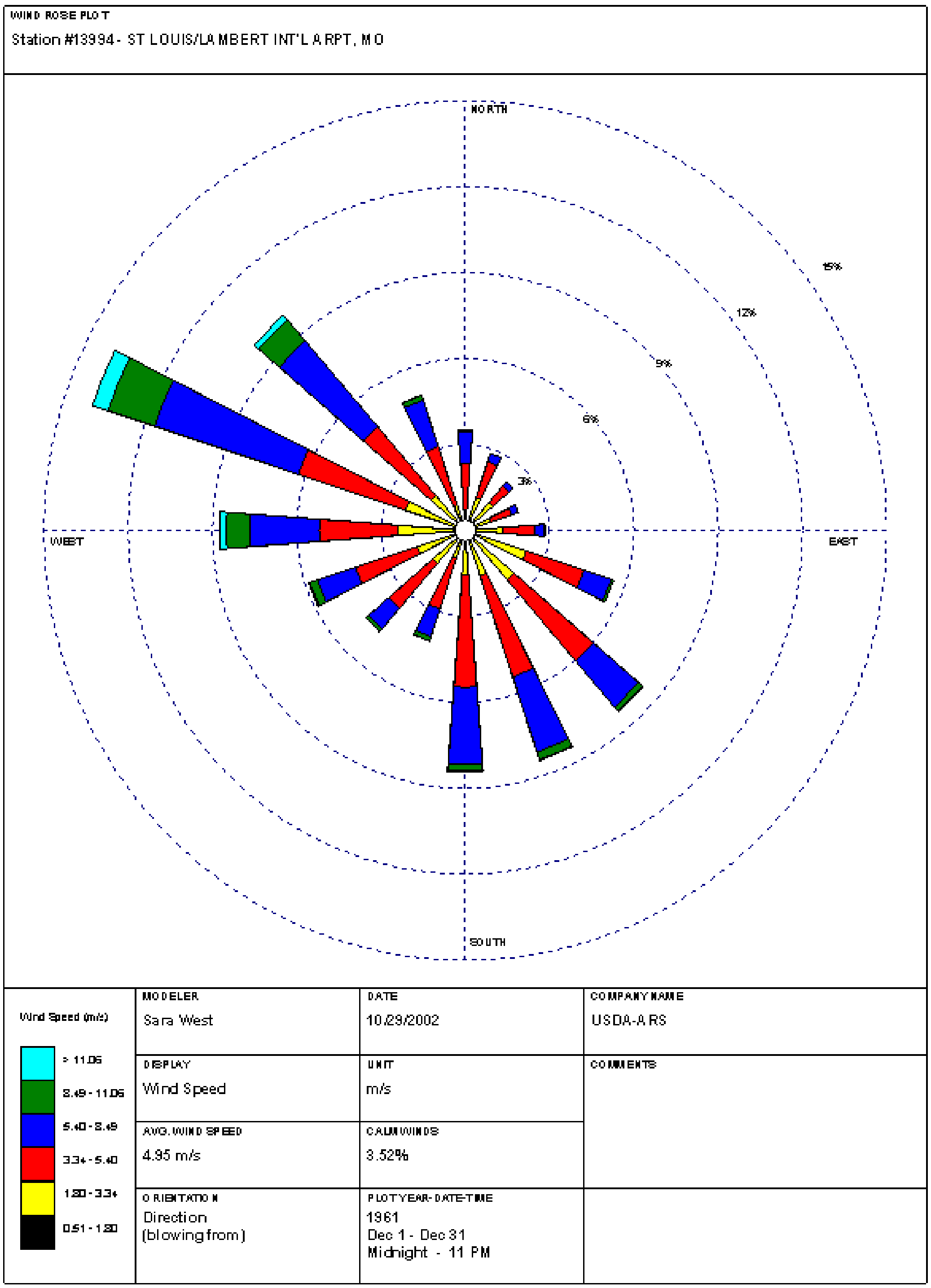


Figure B11: Month of December Wind Rose Plots from 1961 to 2002



B1.5 Existing Air Quality for SO_2 in Missouri

Sulfur dioxide is a colorless gas with a strong, suffocating odor. It can cause irritation of the throat and lungs, leading to difficulty breathing, increased asthma symptoms and more respiratory illnesses. Sulfur dioxide is one of the U.S. Environmental Protection Agency's (EPA) criteria air pollutants. Criteria pollutants are commonly found air pollutants that, at high enough levels, can harm human health and the environment.

The primary source of SO_2 emissions is the combustion of sulfur-bearing coal for power generation, either by utilities or by industries. As coal is burned, the elemental sulfur combines with oxygen to form gaseous SO_2. The sulfur content of coal varies widely, from less than one percent to over three-and-one-half percent. The life span of gaseous SO_2 is limited because it is quickly oxidized further into sulfate (SO_4^{2-}). The sulfate binds to atmospheric ammonium (NH_4^+) to form ammonium sulfate, one of the major constituents of another criteria pollutant-Fine Particulate Matter ($PM_{2.5}$).

In 2010, the NAAQS for SO_2 was revised, revoking the annual and 24-hour standards. Previous to the revision, the entire state of Missouri was designated as attainment or unclassifiable under the annual and 24-hour standards. The current primary standard is based on a three year design value, which is calculated by taking the 99^{th} percentile of the daily high 1-hour average concentrations recorded each year, for three years, and averaging the three years together. The 1-hour standard is 75 ppb. The secondary standard for SO_2 is 500 ppb, not to be exceeded once per year.

As a result of the new primary SO_2 standard, the State of Missouri was required to submit to the EPA a recommendation regarding the attainment status of all areas within the state. Non-attainment was recommended for portions of Jefferson, Jackson, and Greene Counties; the remaining counties in the state, as well as the remaining portions of Jackson, Jefferson, and Greene Counties, are recommended for designation as unclassifiable.

B1.6 Monitoring Site Descriptions

Three locations have been identified for this air monitoring program; two of these are felt to be specifically suitable for air quality monitors, one of those two and a third are felt to be suitable site locations expressly for meteorological monitors. The site locations were selected based on the stated purpose of the monitoring program, sampling probe and monitor siting and exposure criteria described in Section B.1.1, the data quality objectives for each of the proposed target parameters and eventual use of the resultant sampling data. All proposed sites are located outside of the perimeter of the Labadie Energy Center.

Northwest Monitoring Site ("Northwest Site") will monitor SO_2. It is situated approximately 3.2 km northwest of the Labadie Energy Center in a farm field located off of Route 94 in Augusta, Missouri. The land surface is typical of an active farm field and the monitor will be located so as to be away from any potential obstructions. Potential obstructions consist of heavily wooded areas that surround the farm field. The distance to the nearest of these wooded areas is 95m, equivalent to approximately 9 to 10 times the height of the trees. The nearest distance from the monitor to Route 94 is 25m. Spacing of the site from all roadways, obstructions and potential nearby sources conforms to relevant EPA siting and exposure guidelines for the pollutant compound to be monitored. The geographical coordinates of the NW Site are Latitude: 38^o 34' 54.48" N; Longitude: 90^o 51' 55.90" W.

Figure B12 presents an overhead view of the area immediately surrounding this site; Figure B13 presents photographic views of the site location looking towards the site; and Figure B14 presents photographic views of the site location looking away from the site. This site offers good exposure for monitoring airborne pollutants carried by prevailing winds from the south and southeast. It is situated on a rectangular-shaped parcel of level farm land. The site is bordered on the north by Route 94 and is situated approximately 1.7 km northeast of Augusta, Missouri. The area is sparsely populated and remains primarily rural farmland. Route 94 is a Missouri Department of Transportation maintained road and is classified as a minor arterial; although it is a two-lane road in the rural southwestern part of the county that the site is located in. The average daily traffic volume for Route 94 east of Route T in 2004 was 2900 vehicles, up 0.0% from 2000. The Northwest monitoring site is approximately 3 km east of the Route 94/T intersection.

Valley Monitoring Site ("Valley Site") will monitor SO_2 and meteorological parameters. The Valley Site is located approximately 3.7 km east-northeast of the Labadie Energy Center in a farm field off of Labadie Bottom Road. The topography of the site locale is generally level except for minor grade changes ≤ 3.1m (10 feet) extending to the Labadie Energy Center. This site is situated on land with natural ground cover that is actively farmed and is virtually treeless extending to the Labadie Energy Center to the west and over 700 m in all other directions from the site. Labadie Bottom Road is an unpaved farm access road with minimal vehicular traffic. The geographic coordinates for the Valley Site are Latitude: 38^o 34' 21.08" N; Longitude: 90^o 47' 48.88" W. Figure B15 presents an overhead view of the area immediately surrounding this site; Figure B16 presents photographic views of the site location looking towards the site; and Figure B17 presents photographic views of the site location looking away from the site.

Tall Tower Meteorological Monitoring Site ("Tall Tower Met Site") is a meteorological monitoring site only. The Tall Tower Met Site is located approximately 4.7 km east of the Labadie Energy Center on an elevated stretch of wooded area off of Highway T in Franklin County, Missouri. The meteorological sensors will be mounted at the 30 m and 65 m levels on a guyed lattice 91.4 m communications tower at a pipeline station situated at the highest point on an elevated, treed area. The elevation of the tower site is 220.9 m above mean sea level, for an overall height above mean sea level of 312.3 m. A dense line of deciduous trees and a communication building are in the vicinity of the Tall Tower Site. The wind monitors will be measured at these heights to ameliorate any effects from communications equipment installed at higher heights on the tower. The geographic coordinates of Tall Tower Site are Latitude: 38^{o} 33' 43.15" N; Longitude: 90^{o} 46' 58.82" W. Figure B18 presents an overhead view of the area immediately surrounding this site; Figure B19 presents photographic views of the site location looking towards the site; and Figure B20 presents photographic views of the site location looking away from the site.

Figure B12: Overhead View of Northwest Monitoring Site

Figure B13: Photographic Views Looking Towards the Northwest Site

Looking Towards the Site from the North

Looking Towards the Site from the South

Looking Towards the Site from the East

Looking Towards the Site from the West

Figure B14: Photographic Views Looking Away From the Northwest Site

Looking From the Site to the North

Looking From the Site to the South

Looking From the Site to the East

Looking From the Site to the West

Figure B15: Overhead View of Valley Monitoring Site

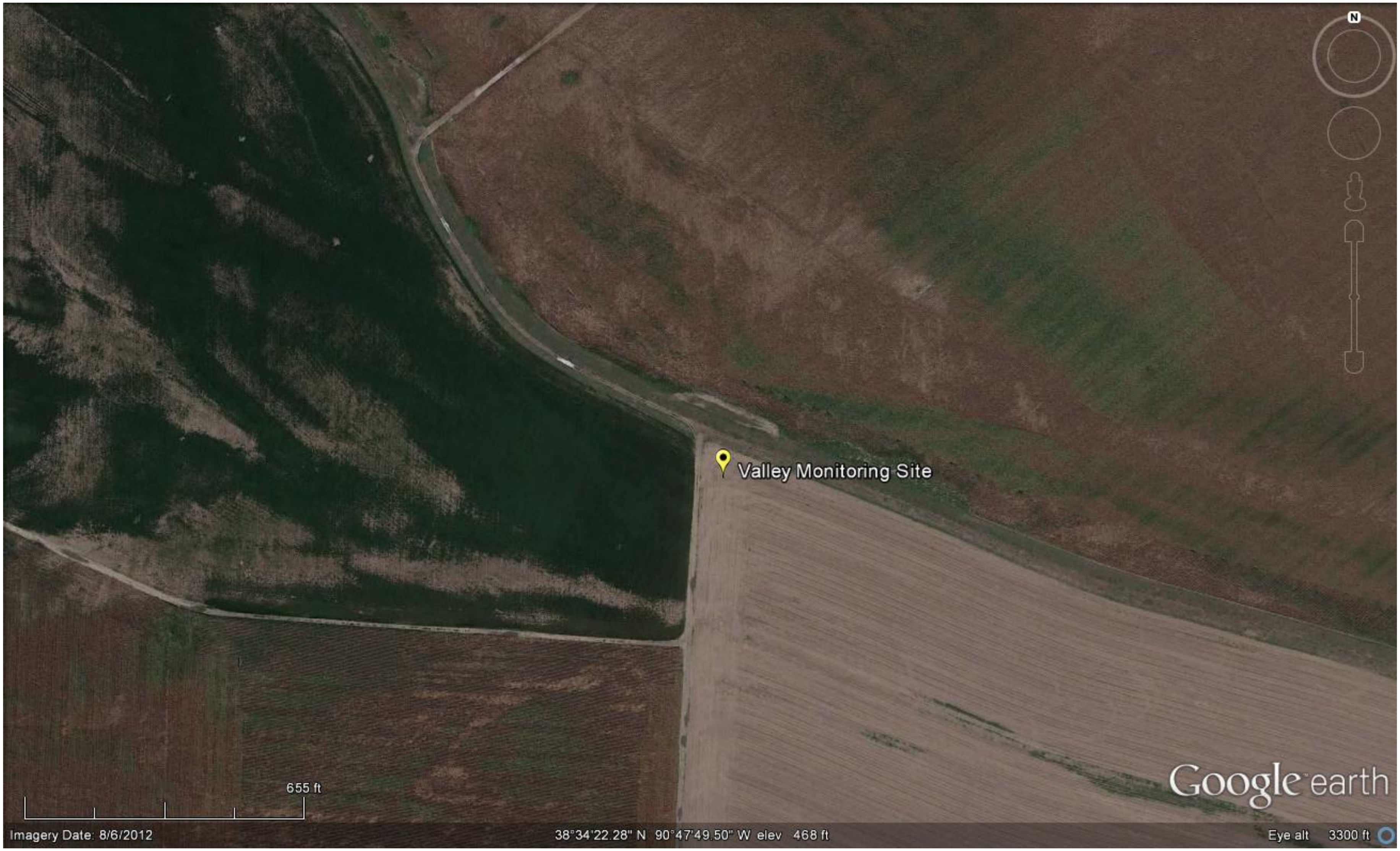


Figure B16: Photographic Views Looking Towards the Valley Site

Looking Towards the Site from the North

Looking Towards the Site from the South

Looking Towards the Site from the East

Looking Towards the Site from the West

Figure B17: Photographic Views Looking Away From the Valley Site

Looking From the Site to the North

Looking From the Site to the South

Looking From the Site to the East

Looking From the Site to the West

Figure B18: Overhead View of Tall Tower Met Monitoring Site

Figure B19: Photographic Views Looking Towards the Tall Tower Site

Looking Towards the Site from the North

Looking Towards the Site from the South

Looking Towards the Site from the East

Looking Towards the Site from the West

Figure B20: Photographic Views Looking Away From the Tall Tower Site

Looking From the Site to the North

Looking From the Site to the South

Looking From the Site to the East

Looking From the Site to the West

B2. SAMPLING METHOD REQUIREMENTS

This section describes features and performance specifications for the monitoring and calibration equipment that will be used in the monitoring program. The sampling equipment to be used for this monitoring program consists of monitoring stations (shelters), continuous SO_2 monitors, and meteorological towers instrumented for the continuous measurement of a full suite of meteorological parameters.

All monitors used for measuring criteria pollutants (i.e., SO_2) for the monitoring project carry EPA equivalent method designations and will be operated in conformance with method designation requirements. The monitoring support equipment will meet the requirements discussed below.

B2.1 Monitoring Equipment Shelters

At each SO_2 monitoring site all monitoring equipment (except meteorological monitors and their support towers) will be installed and operated inside temperature-controlled equipment shelters. Each shelter will be equipped with an industrial grade, wall-mounted air conditioning and heating unit (18,000 Btu cooling capacity and 5KW heating capacity) and central thermostat for temperature control. The temperature within each shelter will be continuously monitored and recorded using a calibrated Comet Model TO 218 temperature transmitter interfaced to the data acquisition system (DAS or data logger). The climate control system for each monitoring shelter will be capable of maintaining a stable temperature within the range of 20° to 30°C with an average variability of ±1.5°C over a 24-hour interval. The shelter temperature will be continuously monitored as the data is required to verify pollutant monitors are operated within the temperature range specified by the US EPA as a condition Equivalent or Reference Method designation for the monitor; this data will be acquired and reported by the on-site data logger.

The monitoring shelters, an EKTO Model 888, will measure 8 feet wide by 8 feet long by 8 feet high. Each shelter will be anchored and secured to a concrete pad for safety. A padlocked exterior compartment attached to an outer wall of the shelter will safely house all compressed support gases. Each monitoring shelter is constructed on a rugged galvanized steel frame with extruded aluminum studs. Exterior and interior wall coverings are white aluminum sheet metal fastened with blind rivets to the supporting structural components. All edges and joints are sealed with a industrial-grade, weatherproof sealant. Interior floor coverings are commercial-grade linoleum tile. Each shelter is fully insulated (R-11) with closed-cell foam insulation and equipped with a fully gasketed and insulated self-closing 36" door with a cam lock handle.

Each shelter will be equipped with electrical service panels, interior electrical distribution circuits, lighting, workbench; and sufficient space for housing, operating, and maintaining the monitoring instruments. All electrical wiring and appurtenances will conform to the National Electric Code (NEC). Each shelter electrical service and the shelter building itself will be grounded to earth in conformance with NEC and local code requirements.

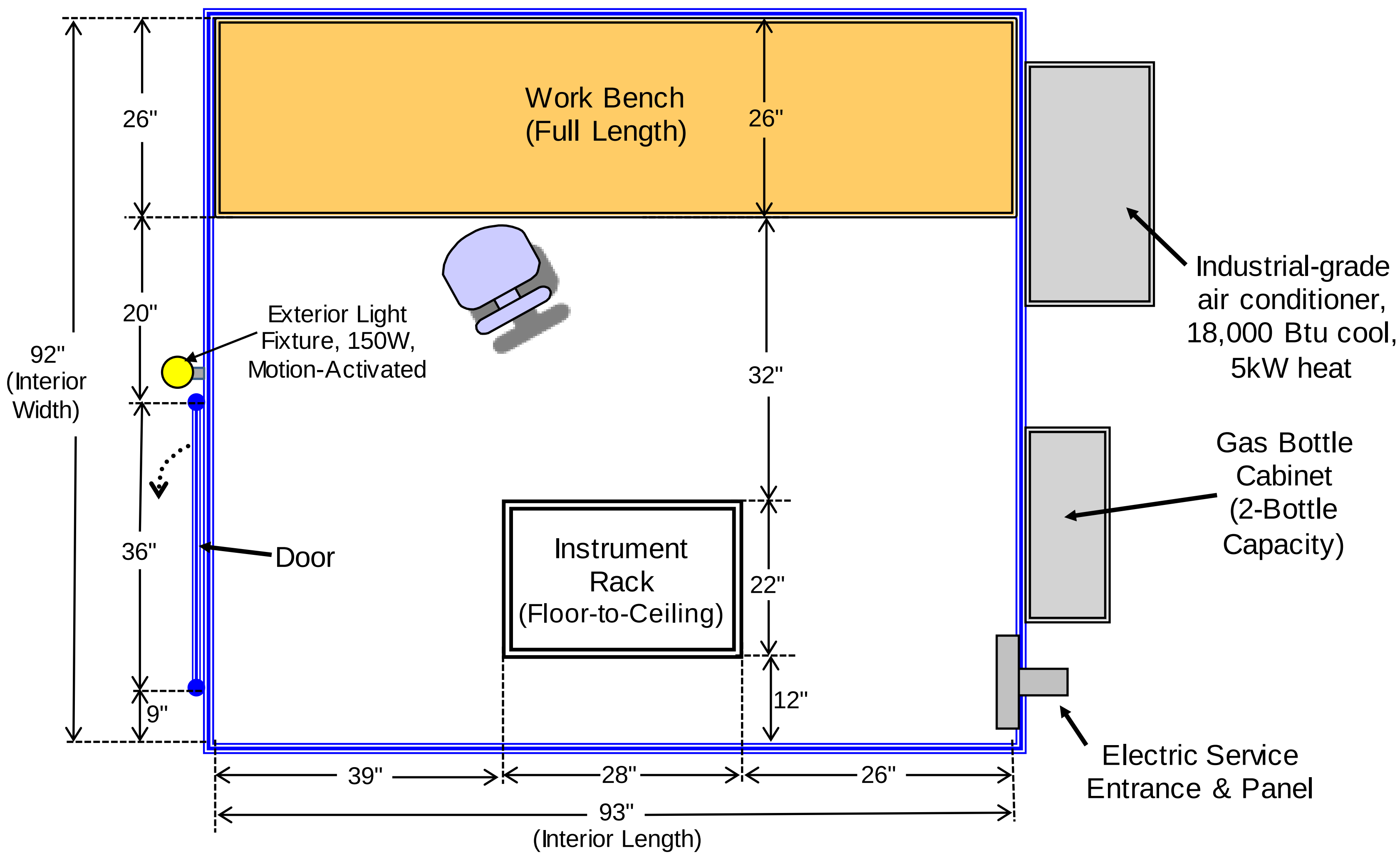
All internal electrical power distribution circuits will be protected against power line surges, transients and noise by installation of an Emerson Model IM120S160 AC Surge Protector. The IM120S160 is wired directly to the service panel within the shelter. Response time to surges and transients is <0.5 nanoseconds. It provides 160kVA protection between all legs of the power service. EMI/RFI attenuation is typically -40dB. Front-panel status LEDs provide visual indication of protection status. A dry contact closure integrated with the on-site data logger will provide remote sensing of any fault condition.

The exterior corners of each shelter will be equipped with welded-on lift rings designed to permit easy loading/off-loading of the shelter from a transport flatbed trailer and also accept tie-down anchoring attachment hardware.

The shelters feature 3” (H) x 2” (W) structural skids that run the entire length (front to rear) of the underside. These skids make deployment and secure set-down on a gravel-and-timber support pad convenient and easy, and protect the exterior floor surface from damage. Each shelter will be anchored and secured on a shelter support pad of timber and gravel and will be anchored using helical screw anchors, load-rated wire rope and turnbuckles attached to the four shelter lift rings.

Figure B21 contains the monitoring station layout.

Figure B21: Monitoring Station Layout for the Labadie Sulfur Reduction Project



B2.2 Sample Air Intake and Delivery Systems

At each monitoring station, the sample air intake and delivery systems will conform to the guidance contained in 40 CFR. Part 58, Appendix E. The system is designed so that the total sample residence time is substantially less than 10 seconds. All components of the sample delivery system for SO_2 will be constructed of ¼” OD FEP Teflon tubing. The sample intake probe assembly will extend horizontally outside of the shelter wall at a height of approximately 3m above ground level. The sample probe inlet will have 180^o unrestricted airflow for sample air intake. It will be designed to prevent large particles (i.e. insects) from entering the transport tube. A small mesh, stainless steel screen surmounts the sample probe inlet.

B2.3 Continuous SO_2 Monitoring

Ambient concentrations of sulfur dioxide (SO_2) will be continuously measured using Teledyne Advanced Pollution Instrumentation (TAPI) Model T100 UV Fluorescence automated SO_2 monitors that are designated as Equivalent Method Number EQSA-0495-100 by the US EPA in accordance with 40CFR Part 53, Subparts A and C. The SO2 monitors shall be operated and maintained in accordance with all corresponding EPA equivalent method requirements.

The TAPI Model T100 UV Fluorescence SO_2 Analyzer is a microprocessor controlled analyzer that determines the concentration of sulfur dioxide (SO_2), in a sample gas drawn through the instrument’s sample chamber where it is exposed to ultraviolet light, which causes any SO_2 present to fluoresce. The instrument measures the amount of fluorescence to determine the amount of SO_2 present in the sample gas. Stability is achieved with the use of an optical shutter to compensate for sensor drift and a reference detector to correct for changes in UV lamp intensity. Additionally an advanced optical design combined with a special scrubber, called a "kicker" that removes hydrocarbons (which fluoresces similarly to SO_2) prevents inaccuracies due to interferents.

This analyzer has a lower detectable limit (LDL) of 0.4 ppb. The zero drift is specified as less than 0.5 ppb/24 hours, and the span drift is specified as less than 0.5 percent of full scale/24 hours. The analyzer’s zero noise is less than 0.2 ppb and the span noise is less than 0.5 percent of reading above 50 ppb. The linearity of the response of the analyzer is 1 percent of full scale and the precision is 0.5 percent of reading above 50 ppb. The SO_2 monitors will be operated in the 0 to 500 ppb full scale measurement range with temperature and pressure compensation features activated.

All TAPI T Series instruments offer an advanced color display, capacitive touch screen, intuitive user interface, flexible I/0 capabilities, and built-in data acquisition capability. All instrument set up, control and access to stored data and diagnostic information is available through the front panel, or via RS232, Ethernet, or USB com ports either locally or by remote connection using the included APIcom™ software.

SO_2 measurement data will be recorded as one-minute, five-minute and hourly block-averaged concentrations measured in parts per billion (ppb). The SO_2 monitor will be set to operate with a full-scale measurement range of 0 to 500 ppb with an internal averaging time setting of 30 seconds. Standard operating procedures for the TAPI Model T100 UV Fluorescence SO_2 analyzer are provided in Appendix 9. Figures B22 and B23 present photographs of similar instrument rack layouts.

Figure B22: Instrument Rack Layout - Front View

Figure B23: Instrument Rack – Rear View

B2.4 Meteorological Monitoring

Meteorological data will be collected at two separate site locations (Valley Site and Tall Tower Site) using meteorological monitoring equipment that meets the technical and performance specifications contained in the publication "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005, February 2000). Table B1 lists the equipment utilized, the measurement frequency and sampling averaging times for the meteorological parameters, Table B2 lists the specifications for the equipment utilized in the program, and Table B3 lists the meteorological parameters monitored and heights at which the measurements will be made at the Valley and Tall Tower Sites.

B2.4.1 Valley Site Meteorological Monitoring

At the Valley Site, the meteorological instrumentation will be installed on a 10m, heavy-duty aluminum tower. The 3-sided, open latticework tower is fabricated using a high-strength aluminum alloy in ten-foot sections and is engineered for the specified wind load per EIA RS-222D. The tower will not twist, rotate or sway, providing a rigid platform for mounting the sensors.

The tower features hinged base leg brackets that permit the tower to be pivoted down into a horizontal position for easy servicing of the sensors. The towers can easily be tilted down (and up) by means of a gin pole equipped with a stainless steel winch, pulley and wire rope mechanism. This design allows a single person the capability to access the meteorological instruments mounted at the top of the tower for maintenance or testing without the need for climbing or use of ladders. The tower will incorporate full height grounding, signal line protection, and thermostatically-controlled heater jackets for the wind sensors (described below).

The meteorological parameters monitored at the Valley Site include horizontal wind speed, vertical wind speed, the standard deviation of the vertical component of wind speed (σ_W), wind direction, and the standard deviation of wind direction (σ_θ), all at a height of 10 m; ambient temperature at 2m and delta temperature at 10 m; relative humidity at 2 m; solar radiation at 1.5 m; barometric pressure at 2 m; and precipitation at 1 m.

B2.4.2 Tall Tower Met Site

At the Tall Tower Met Site, meteorological parameters monitored will include horizontal wind speed, vertical wind speed, the standard deviation of the vertical component of wind speed (σ_W), wind direction, and the standard deviation of wind direction (σ_θ), at a height of 30 m and 65 m; and air temperature at a height of 30 m and 65 m. These sensors will be located on a guyed lattice communications tower with an overall height of 91.4 m.

B2.4.3 Meteorological Equipment

Horizontal Wind Speed and Wind Direction Sensors: Wind speed and wind direction will be continuously monitored using Climatronics F460 wind sensors. The Climatronics F460 wind monitors are designed specifically for use in systems for PSD and modeling applications. Rugged construction, low starting thresholds, quick response, high accuracy and minimum maintenance requirements make the F460 an excellent instrument for use in air quality monitoring programs.

The F-460 wind direction sensor consists of a counterbalanced, lightweight vane coupled to a low torque, precision potentiometer. The sensor/potentiometer output is proportional to the wind direction vane position. The Model F-460 wind direction sensor has a low starting threshold (≤ 0.22 meters per second, or m/s) and a high damping ratio or short reaction delay. The instrument has an electrical response range for azimuth of 0 to 359 degrees. The accuracy of the sensor's azimuth response is within ±3 degrees of True. Operating temperature range of the sensor is between –50 degrees to +65°C.

Measurement data for wind direction will be collected and reported as vector-averaged hourly block values scaled in degrees of azimuth referenced to True North (= 0 degrees). Hourly-averaged sigma theta values (the standard deviation of the horizontal wind direction) will be calculated and stored by the on-site data acquisition system using EPA-recommended algorithms.

The Model F-460 wind speed sensor employs a three-cup anemometer coupled to a photo-chopper with an LED assembly that provides a pulsed frequency output signal that is directly proportional to the wind speed. The non-degrading characteristic of the photo-chopper technique has proven extremely accurate and reliable. The Model F-460 wind speed sensor has a starting threshold of ≤ 0.22 m/s and fast response. The sensor accuracy is ± 1% over its entire calibrated range. The sensor will have a calibrated measurement range of 0.0 to 100.0 miles per hour (mph). Response to changing wind speed is less than 3 feet of air flow. Operating temperature range of the sensor is between –50° to 65°C. Measurement data will be collected and reported as vector-averaged hourly block values scaled in mph.

<u>Vertical Wind Speed Sensor</u>: Vertical wind speed will be measured using the Climatronics Model 102236 Vertical Component Anemometer with an Expanded Polystyrene Gill Propeller. This instrument features exceptionally low threshold and fast response through the use of low-friction precision bearings and a photo-chopper with an LED assembly. The anemometer body is slender and aerodynamic to ensure that minimal turbulence is introduced into the measured air stream. The vertical component anemometer will be supplied with an expanded polystyrene propeller for superior sensitivity and threshold of response (equal to 0.3 mph). Propeller rotation causes a precision-slotted shutter to interrupt a solid-state light source. This pulse signal is processed by an internal signal conditioner which utilizes state-of-the-art surface mount technology. The sensor outputs a linear millivolt DC output directly proportionate to the instantaneous vertical wind speed.

<u>Ambient Air Temperature and Temperature Difference Sensors</u>: Ambient air temperature and temperature difference will be continuously measured using Climatronics Model 100093 temperature sensors mounted in a Climatronics Model 100325 motor-aspirated radiation shield. The Model 100093 is a multi-element thermistor encased in a stainless steel sheath and is designed to produce a large electrical resistance change in response to relatively small changes in temperature. The air temperature measurement system will have a range of –22.0° to +122.0°F. Total system accuracy will be ± 0.5°C for air temperature and ± 0.1°C for temperature difference. Response time to temperature change is less than 10 seconds. The measurement data will be reported as hourly block averages scaled in °F.

Relative Humidity Sensors: Relative humidity (RH) will be measured at a height of 2m AGL using the Climatronics Model 102273 thin-film capacitive sensor, an exceptionally stable sensor with response time of (≤10 seconds without filtering). This sensor requires a minimum of maintenance or calibration and features exceptional resistance to contaminants. Repeatability is excellent, even after complete sensor saturation. The Model 102273 sensor maintains its accuracy over the full range of humidity, even in conditions close to condensation. This is accomplished by electronic temperature compensation.

The sensor's signal is processed by an internal signal conditioner which utilizes state-of-the-art surface mount technology. The sensor output is a 0-1VDC signal that is directly proportionate to the instantaneous RH condition.

Radiation Shields: The air temperature and temperature difference sensors will be housed within the Climatronics 100325 radiation shield to minimize bias of the data that can result from solar radiant heating effects and insolation. The Model 100325 radiation shield is motor-aspirated, providing a continuous flow of ambient air past the sensors to yield accurate measurement values, and has superior serviceability features. The quick-release motor cover and convenient access to the probe housed within make it one of the most serviceable tower-mounted aspirators available. The forced aspiration and triple shield design ensure that errors resulting from radiation and insolation effects are minimized to less than 0.2^{o}C.

The relative humidity sensor will be housed within the Climatronics Corp. Model 102818 6-plate, Gill-type, naturally-aspirated radiation shield. This radiation shield will protect the relative humidity sensor from precipitation and minimize errors resulting from radiation and insolation effects.

Solar Radiation Sensor: Measurement of incoming global solar radiation (consisting of both direct and diffuse components) will be made using the Eppley 8-48 (Black and White) pyranometer. The model 8-48 meets WMO specifications established for first-class category pyranometers. The detector is a differential thermopile with the hot-junction receivers blackened and the cold-junction receivers whitened. The element is of radial wire-wound-plated construction with the black segments coated with 3M black and the white with Barium Sulfate. The alternating hot-and-cold thermopile junctions eliminate the negative nighttime bias exhibited by other pyranometers.

The Model 8-48 also features built-in temperature compensation with thermistor circuitry to free the instrument from the effects of ambient temperature. A precision ground optical glass hemisphere of Schott glass WG295 uniformly transmits energy from .285 to 2.800 micrometers and seals the instrument from the weather. The cast aluminum case incorporates a circular spirit level, adjustable leveling screws and a desiccator with a visual inspection window. The solar radiation sensor will be mounted on a fixed boom projecting from the tower at 2m AGL. The sensor will be oriented toward the north so as to minimize any shadowing effects from the tower.

Barometric Pressure (BP) Sensor: Barometric pressure (BP) will be continuously measured by the Climatronics Corp. Model 102663-1 temperature compensated, piezoresistive pressure sensor. The 102663-1 features a built-in application-specific integrated circuit (ASIC) which works hand-in-hand with a piezoresistive transducer to achieve long-term stability (sensor calibration drift is <

±0.25% of full scale over 6 months at 70°F) and high accuracy. The sensor provides calibrated pressure readings over the range of 800 to 1,100 millibars (mb) or 23.62 to 32.48 inches of mercury (inHg) with an accuracy of ±0.1% of full scale (< ±0.3 mb or < ±0.01 inHg) over an operating temperature range of -20° to 80°C.

Precipitation Gauge: Liquid and frozen precipitation will be continuously measured by the Climatronics Corp. Model 100097-1 precipitation gauge. The100097-1 is a tipping-bucket type gauge featuring a large eight-inch diameter collection opening and a thermostatically-controlled, internal heater for accurate measurement of both frozen and liquid precipitation. As a tipping-bucket type gauge, there is essentially no upper limit to the measurement range. Measurement resolution is 0.01 inch of precipitation (one bucket tip). Measurement accuracy is ±1% for rainfall up to three inches per hour; ±3% for rainfall between three and six inches per hour. Data are reported as total inches of precipitation per hour and also total daily precipitation.

Appendix 9 contains Standard Operating Procedures (SOPs) for each for the calibration, routine maintenance and audits of meteorological sensors.

In addition to the direct-measurement meteorological parameters, the data logger uses EPA-approved algorithms to calculate vector-averaged values for horizontal wind speed and wind direction as well as sigma theta and sigma w values. All calculated values are derived from instantaneous, sequential measurement values collected over the course of the averaging interval. The data logger also calculates the temperature difference between the upper and lower temperature sensors, compiling and storing the averaged temperature difference values. The data logger similarly computes and stores the total rainfall for each hour. Table B4 lists the AQS measurement method codes and method reference for each parameter to be reported.

B2.5 Environmental Controls

At each monitoring site all monitoring equipment (except meteorological monitors and their support towers) will be installed and operated inside temperature-controlled equipment shelters. To maintain the specified operating temperature of the continuous analyzers, each monitoring shelter will have an industrial-grade climate control system. It features energy efficient cooling and heating performance in one self-contained unit. This unit is housed in a heavy gauge, galvanized steel cabinet protected by a high quality, UV resistant powder paint finish. Installed through the wall, product features include an energy efficient compressor, 18,000 BTU of cooling capacity, and 5 kW electric heating with phenolic coated evaporator and condenser coil. The climate control system for each monitoring shelter will be capable of maintaining a stable temperature within the range of 20 to 30 °C with an average variability of ±1.5°C over a 24-hour interval. The temperature within each shelter will be continuously monitored and recorded using a calibrated Comet Model TO 218 temperature transmitter connected to the data acquisition system (DAS or data logger).

B2.6 Data Acquisition System ("DAS")

All monitors will be integrated with a Campbell Scientific Model CR1000 data logger to provide data acquisition, compilation and local storage of 1-minute, 5-minute and hourly average data values, support bi-directional data communications, control automatic calibration functions and also provide any necessary operating and reference voltages for each meteorological sensor. All signal connections between the data logger and meteorological sensors on the tower will incorporate commercial-grade surge protection circuitry to protect the data logger and downstream electronics from electrical surge damage.

The CR1000 data logger scans, digitizes and integrates each input measurement value at a rate of once per second. A 12-bit analog-to-digital (A/D) converter converts each analog input signal to a digital value. Digitized values are scaled to engineering units and/or processed using pre-defined algorithms in accordance with the data logger program instructions. The scaled and calculated values are stored for subsequent compilation of 1-minute, 5-minute and hourly block averages. The data logger uses EPA-approved algorithms to calculate vector-averaged values for horizontal wind speed and wind direction as well as sigma theta and sigma w values. All calculated values are derived from instantaneous, sequential measurement values collected over the course of the averaging interval. The data logger also calculates the temperature difference between the upper and lower temperature sensors, compiling and storing the averaged temperature difference values. Total maximum measurement error is a negligible ±0.2% of full scale range (FSR).

The CR1000 data logger stores programming instructions in non-volatile memory. Measurement data are stored in battery-protected SRAM and also in removable flash memory, thereby preventing data loss in the event of a power outage. Each data logger will be equipped with sufficient flash memory to store approximately one year of data.

The data logger will be configured so that any data-averaging interval that is missing the full number of possible scanned samples for that averaging interval will be automatically appended with an appropriate status flag. A minimum of 75% of all possible instantaneous values in a given averaging interval is needed to formulate a valid averaged data value. The data logger automatically excludes any missing or invalid data samples from final averaged values. Averages that contain less than 75% of total possible valid samples will be appended with other flags indicating an invalid average, depending on the cause of the missing or invalid samples (e.g., a power outage, instrument maintenance or calibration).

The Model CR1000 data logger includes the following features:

- User-entered configuration parameters will be stored in battery backed-up memory.

- In the event of a power outage at a site, the internal backup battery will maintain the system clock and internal SRAM memory for a minimum of 30 days. Each data logger will ensure configuration parameters; date and time functions are maintained during any power interruptions. The data logger software and hardware will handle power service interruptions gracefully, and maintains a log of any such events.

- A log of any power outage and other user-defined events will be automatically maintained and available for download and review. The “Begin” and “End” times and date(s) will be identified in this log for each such event.

- Each data logger will be programmed to activate, control and report the results of daily two-point (Level 1 zero/span) calibration drift checks on each continuous gaseous pollutant monitor. Additionally, each data logger will be programmed to activate, control and report the results of weekly data one-point quality control checks on each continuous gaseous pollutant monitor. Results of these checks are essential to the data validation and data reporting requirements.

- Each data logger will be integrated with a Comet TO 218 temperature transmitter to measure and record the internal shelter temperature, allowing data reviewers to verify that all pollutant monitors are operating within the temperature range specified by the U.S. EPA.

- Full Ethernet and RS-232C communications capability will be supported for interrogating the DAS and downloading data either via the on-site modem and cellular telephone service or locally via a data terminal interface. All data logger functions will be accessible through local or remote communications. Communications with the data logger and configuration changes are restricted through built-in, multi-level password-protection.

The 1-minute, 5-minte and hourly block-averaged data stored by the data logger will be automatically uploaded on a daily basis from the data logger to a personal computer located at Enviroplan Consulting's central Data Management Center (DMC) in Wayne NJ by means of an on-site cellular telephone modem and automated data polling software. The 1-minute data will be reviewed by Enviroplan Consulting's data technicians and quality assurance personnel as time-series graphical data for quality assurance in support of data validation. The 5-minute averaged SO_2 data will be utilized to assess and report short-term ambient SO2 concentrations in accordance with recent revisions to the EPA National Ambient Air Quality Standards (NAAQS) for SO_2. All other data will be reported as hourly block-averaged values with additional statistical analyses of the data calculated and reported as required. Additional features of remote data communications include complete driver software for communicating with and logging information from the continuous pollutant monitors. This allows effortless local and remote review of internal operating parameters for all monitors.

Local interface with the Campbell Scientific CR1000 data logger will be made via an IBM-compatible desktop personal computer (PC) running Windows 7 and Campbell Scientific PC-200W software. This will enable local operating personnel to record data onto the PC hard drive (providing additionally redundant on-site data archival), obtain current measurement values and confirm current time and date information.

The on-site data logger will provide a comprehensive data file for accurate and efficient reduction, processing and validation review. All data will be referenced to Local Standard Time, with status flags attached as appropriate to mark periods during which the monitors are undergoing calibration checks or maintenance. Power outages and other significant information will be similarly recorded and readily related to the data.

Table B4: Monitored Parameters, AQS Parameter, Method, Duration, and Report Unit Codes

Monitored Parameters	Parameter Code	Method Code	Duration Code	Reported Unit
SO_2	42401	100	1	8
SO_2	42401	100	H	8
Horizontal Wind Speed - Scalar	61101	63	1	12
Horizontal Wind Speed - Vector	61103	20	1	12
Vertical Wind Speed	61109	20	1	12
Standard Deviation of Vertical Wind Speed	61110	20	1	12
Horizontal Wind Direction - Scalar	61102	63	1	14
Standard Deviation of Horizontal Wind Direction - Scalar	61106	20	1	14
Horizontal Wind Direction - Vector	61104	20	1	14
Standard Deviation of Horizontal Wind Direction - Vector	61107	20	1	14
Ambient Air Temperature	62101	40	1	15
Temperature Difference	62106	41	1	117
Relative Humidity	62201	61	1	19
Barometric Pressure	64101	15	1	16
Precipitation	65102	11	1	21
Solar Radiation	63301	11	1	79

B3. SAMPLE HANDLING AND CUSTODY

The Labadie Sulfur Reduction Project is monitoring for SO_2 and meteorological parameters using continuous automated samplers and will not take any physical samples. Sample handling and custody are not applicable to the monitoring project.

B4. ANALYTICAL METHODS REQUIREMENTS

The Labadie Sulfur Reduction Project is monitoring for SO_2 and meteorological parameters using continuous automated samplers that do not require further analysis. Analytical methods and requirements are not applicable to the monitoring project.

B5. QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) procedures are required for this project to ensure that the collected ambient air and meteorological data meet standards of reliability and accuracy. Quality control (QC) procedures include multi-point calibrations, “Level 1” zero/span checks, and one-point quality control checks of the continuous gas analyzers, and calibration checks on the meteorological monitors.

All monitoring equipment is acquired from manufacturers whose equipment meet EPA ambient air and meteorological monitoring guidelines, and are certified by the operator and auditor over the operating range for the expected conditions at each station. Equipment for the monitoring program meeting EPA requirements has been chosen from vendors with a proven history of providing equipment that will last the life of the monitoring program. All analyzers are certified by the operator and auditor over the operating range for the expected conditions at each station.

Table B5 summarizes routine quality control activities, the minimum frequency for which these checks and activities will be performed, associated acceptance criteria, control limits and corrective actions as pertains to the continuous gaseous pollutant and meteorological monitoring systems. Equations used to calculate QA/QC statistics are presented in Section D3. Additionally, method-specific data validation tables for each method are included in Appendix 4 in accordance with EPA and MDNR QAPP requirements.

All calibration sources and equipment utilized will be traceable to the National Institute of Standards and Technology (NIST) or other authoritative standard. All applicable calibration equipment will be certified on a required, scheduled basis. Results of all calibrations of continuous monitors will be entered in the station logbook and on appropriate calibration forms.

Comprehensive checklists specific to the monitoring system will be completed by the local field operator during each site visit. The operational status and history of each monitoring system component will be documented through on-site log notes, repair histories and status check forms. This information will include certificates of calibration for all test and monitoring equipment employed during the monitoring program.

Standards are defined for instrument drift and response control limits, and the program will require that documented investigative action and corrective measures be taken should these standards be exceeded. Frequent contact between the local field operator for the monitoring station and Enviroplan Consulting monitoring program supervisory personnel, in conjunction with the daily data review, monthly data processing, final data validation and reporting, and independent audits, all contribute to maintaining a consistently high standard of performance.

A formal program of reporting irregularities, non-conformance or deviation from the QAPP, Out-of-Control instrument operating conditions, or audit failure to the Project Manager ensures that any problems will be promptly identified, addressed and resolved, thereby ensuring the quality of the data and integrity of the program.

B5.1 Multi-point Analyzer Calibrations

Multi-point calibrations of the continuous gas analyzers are conducted manually upon initial installation and on a semi-annual basis thereafter by personnel designated by the project manager. In addition, a multi-point calibration is conducted after any major instrumental repairs. Multi-point calibrations are used to establish or verify the linearity of the gas analyzers. Multipoint calibrations consist of a zero concentration and four upscale test point concentrations, the highest being a concentration of approximately 80 percent of full-scale, and three or more concentrations spaced approximately equally over the scale range.

Adjustments to the analyzers may be made during the multi-point calibration process, provided the unadjusted ("as is") analyzer response for each test concentration is obtained before any adjustments are made to the analyzer. Once the unadjusted analyzer response is recorded, the analyzer zero and span adjustment controls may be adjusted based on the zero and highest test concentrations, respectively. After the zero and span adjustments are completed and the analyzer has stabilized on these new zero and span settings, all multi-point calibration test concentrations are introduced to the analyzer for the final calibration.

B5.2 Level 1 Zero/Span Calibration

At least daily, Level 1 zero and span calibrations of the continuous gas analyzers are conducted. These two-point analyzer calibrations are used to assess whether the instruments are properly operating and are conducted by challenging the analyzers with a test atmosphere containing zero concentration of the pollutant, and with a test atmosphere containing concentrations of between 70 and 90 percent of the full measurement range in which the analyzer is operating. The challenge gas is sampled through as much of the sample inlet system as practical to mimic actual sampling of ambient air.

All data from the zero and span checks are recorded by the data acquisition system and plotted by the operator on Level 1 zero and span check control flow charts. Agreement between the measured values and the standard values should be within ±10 percent, otherwise the operator will notify the Data Manager, flag the affected data, and recalibrate the analyzer.

B5.3 One-Point Quality Control Checks

One-point quality control (QC) checks of the continuous gas analyzers are conducted at least every two weeks. These one-point QC checks are conducted by challenging the gas analyzers with a standard gas of known concentration. These one-point QC checks may be done in conjunction with the Level 1 zero/span checks described in Section B.5.2, but will be done prior to any zero or span adjustments performed as part of those checks. The concentration of the gas used for these checks should be 0.01 to 0.10 ppm for SO_2. The results of these checks are used to establish the precision and bias of the analyzers as described in Section D.2.1.

Table B5 provides a summary of the perimeter air monitoring program quality control measures.

Table B5: Summary of QA/QC For Field Monitoring Systems				
Monitoring Instrument	**Type of Check**	**Purpose of Check**	**Minimum Frequency**	**Control Limit(s)**
Data Logger	Calibration	Verifies linear calibration relationship between known test input signals and responses (in engineering units) across the measurement range for each initialized data channel.	Upon initial installation	
Automated Gaseous Pollutant Analyzers	Routine Instrument Checks	Verifies and documents operational status indications of analyzer & support equipment	Weekly	Monitor-specific criteria established for operating status indicators
	Automatic (2-Point) Calibration Check	Confirms analyzer response is within established control limits.	Daily	Zero drift ≤ ± 3 PPB over 24 hours Biweekly drift of ≤ ± 5 PPB; Span Point: ≤ ±10% of True
	Multi-point Calibration	Establishes and/or verifies linear calibration relationship between known test gas concentrations and analyzer responses across the measurement range.	Upon initial installation, Every 6 months thereafter	Zero Point: ≤ 5 PPB; Non-Zero Points: ≤ ±5% of True
	Level 1 Zero/Span Check	Data validation check; confirms analyzer calibration drift is within established control limits.	Bi-weekly, or if automatic cal check limits are exceeded	Zero drift ≤ ± 3 PPB over 24 hours Biweekly drift of ≤ ± 5 PPB; Span Point: ≤ ±10% of True
	One-Point QC Check	Used to assess the precision and bias of the data based on variability of responses over time.	Bi-weekly	≤ ±10% of True
	Independent Performance and Systems Audit	Assess accuracy of data produced by measurement system. Evaluate degree of conformance of field monitoring operations with QAPP and SOPs. Identify any specific or systemic problems.	Quarterly	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ± 1.5 ppb difference or ±15%

Table B5: Summary of QA/QC For Field Monitoring Systems

Monitoring Instrument	Type of Check	Purpose of Check	Minimum Frequency	Control Limit(s)
Meteorological Monitors	Routine Instrument Checks	Verifies and documents operational status indications of monitors & support equipment	Weekly	Monitor-specific criteria established for operating status indicators. General agreement of current data with prevailing meteorological conditions.
	Calibration	Verifies acceptably accurate measurement system responses to known test conditions across the measurement range.	Upon initial installation, Semi-annually thereafter	Refer to Data Accuracy Objectives stated for meteorological monitoring parameters in Table B11. Other performance criteria also apply (e.g., wind sensor starting torque, aspirator fan operation, etc.)
	Performance and Systems Audit	Verifies acceptably accurate measurement system responses to known test conditions across the measurement range.	Semi-annually	Refer to Data Accuracy Objectives stated for meteorological monitoring parameters in Table B11. Other performance criteria also apply (e.g., wind sensor starting torque, aspirator fan operation, etc.)

Notes to Table B4:

1. Additional checks may be performed to investigate or verify a fault condition and immediately following maintenance that could affect the calibration or performance of the monitor.
2. For functional monitors, maintenance or adjustment will always be preceded by an “As Found” (unadjusted) calibration or QC check to determine the monitor’s performance with respect to established measurement data quality indicators.

B5.4 Data Validation Criteria

Complete data validation criteria can be found in Table B6, SO_2 Data Validation Table and Table B7, Meteorological Sensor Data Validation Table.

The Critical Validation Criteria in Tables B6 and B7 outlines criteria deemed critical to maintaining the integrity of a sample or group of samples. Data that do not meet each and every criterion on the Critical Validation Criteria Table will be invalidated unless compelling reason and justification exist for not doing so. The samples for which one or more of these criteria are not met are invalid unless proven otherwise. The cause for not operating in the acceptable range for each violated criteria will be investigated and future occurrences avoided reducing the likelihood that additional samples will be invalidated.

The QA/QC Operational Evaluations in Tables B6 and B7 outlines criteria that are important for maintaining and evaluating the quality of the data collection system. Violation of a criterion or a number of criteria may be cause for invalidation of the data. The decision to invalidate data will consider other quality control information that may or may not indicate the data are acceptable. Therefore, a sample or group of samples for which one of these criteria is not met is suspect unless other quality control information demonstrates otherwise. The reason for not meeting the criteria is investigated, mitigated, and/or justified.

The Systematic Issues in Tables B6 and B7 outlines criteria important for the correct interpretation of the data but do not usually impact the validity of a sample or group of samples. For example, data quality objectives are included in this table. Not meeting these data quality objectives does not invalidate any of the samples, but may affect the achievement of the MQO.

TABLE B6: SO2 DATA VALIDATION TABLE			
Requirement	**Frequency**	**Acceptance Criteria**	**Information / Action**
CRITICAL CRITERIA			
One Point QC Check Single analyzer	1/ 2 weeks	$\leq \pm$10% (percent difference)	0.01 - 0.10 ppm Relative to routine concentrations 40 CFR Part 58 App A Sec 3.2
Zero/span check	1/ 2 weeks	Zero drift $\leq \pm$ 3 PPB over 24 hours Biweekly drift of $\leq \pm$ 5 PPB Span drift $\leq \pm$ 10 %	Zero drift acceptance criteria as revised in the June 3, 2014 EPA Memorandum
OPERATIONAL CRITERIA			
Shelter Temperature			
Temperature range	**Daily** (hourly values)	20 to 30^o C. (Hourly avg.) or per manufacturers specifications if designated to a wider temperature range	Generally the 20^o-30^o C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance
Temperature Control	Daily (hourly values)	$\leq \pm$ 2^o C SD over 24 hours	
Temperature Device Check	2/year	$\pm$ 2^o C of standard	
Precision (using 1-point QC checks)	Calculated annually and as appropriate for design value estimates	90% CL CV $\leq$ 10%	90% Confidence Limit of coefficient of variation 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	Calculated annually and as appropriate for design value estimates	95% CL $\leq \pm$ 10%	95% Confidence Limit of absolute bias estimate 40 CFR Part 58 App A sec 4.1.3
Annual Performance Evaluation			
Single analyzer	Every site 1/year 25 % of sites quarterly	Percent difference of audit levels 3-10 $\leq \pm$15% Audit levels 1&2 $\pm$ 1.5 ppb difference or $\pm$15%	3 consecutive audit concentrations not including zero 40 CFR Part 58 App A sec 3.2.2
Primary QA Organization (PQAO)	annually	95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation	40 CFR Part 58 App A sec 4.1.4

TABLE B6: SO2 DATA VALIDATION TABLE			
Requirement	**Frequency**	**Acceptance Criteria**	**Information / Action**
Federal Audits (NPAP)	1/year at selected sites 20% of sites audited	Mean absolute difference ± 15%	40 CFR Part 58 App A sec 2.4
State audits	1/year	State requirements	
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/6 months if manual zero/span performed biweekly 1/year if continuous zero/span performed daily	All points within ± 2 % of full scale of best-fit straight line	Multi-point calibration (0 and 4 upscale points)
Zero Air		Concentrations below LDL	
Gaseous Standards		NIST Traceable (e.g., EPA Protocol Gas)	Vendor must participate in EPA Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	1/year	Concentrations below LDL	
Gas Dilution Systems	1/6 months	Accuracy ± 2 %	
Detection			
Noise	NA	0.001 ppm	40 CFR Part 53.20
Lower detectable level	1/year	0.002 ppm	40 CFR Part 53.20
SYSTEMATIC CRITERIA			
Standard Reporting Units	All data	ppb (final units in AQS)	
Completeness	1 hour standard	Hour – 75% of hour Day- 75% hourly Conc Quarter- 75% complete days Years- 4 complete quarters 5-min value reported only for valid hours	40 CFR Part 50 App T Section 3 (b), (c). 5-min values or 5-min max value only reported for the valid portion of the hour reported. If the hour is incomplete no 5-min or 5-min max reported.
Sample Residence Times		< 20 seconds	
Sample Probe, Inlet, Sampling Train		Borosilicate glass (e.g., Pyrex®) or Teflon®	40 CFR Part 58 App E
Siting		Un-obstructed probe inlet	40 CFR Part 58 App E

Table B7: Meteorological Sensor Data Validation Table			
Critical Validation Criteria			
Criteria	***Description***	***Frequency***	***40 CFR Reference EPA QA Guidance***
Standard Reporting Units			
Wind speed	m/s	All data	EPA-454/R-99-005
Wind direction	0-360 degrees		
Temperature	Celsius		
Barometric Pressure	mbar		
Relative Humidity	Percent		
Equipment			
Wind speed sensor	Meets recommended specs in guidance	Purchase	EPA-454/R-99-005
Wind direction sensor			
Temperature sensor			
Barometric pressure sensor			
Relative humidity sensor			
Completeness			
Annual – all parameters	90% hourly data capture/calendar qtr	1 year (all calendar qtrs)	EPA-450/4-87-007
Hourly avg.-all parameters	>45 min/hourly average	hourly average	
Calibration			
All sensors calibrated by manufacturer	According to manufacturer specs and within EPA accuracy criteria	Semi-annually	EPA-454/R-99-005
Performance Audit			
Audit and Calibration Standards	Audit Std independent from Cal Stds	Within std certification freq	EPA-454/R-99-005
Wind speed	Co-located transfer standard	Semi-annually	
WS bearing torque meter	Sensor control method		
Wind direction	Sensor control method		
WD bearing torque meter	Sensor control method		
Temperature	Co-located transfer standard		
Delta temperature	Co-located transfer standard		
Barometric pressure	Co-located transfer standard		
Relative Humidity	Co-located transfer standard		
Solar radiation	Co-located transfer standard		
Precipitation	Burette		
Assessments			
Accuracy Performance Evaluation	All sensors	Semi-annually and within 30 days of site start-up	EPA-454/R-99-005

Table B7: Meteorological Sensor Data Validation Table

QA/QC Operational Evaluations

Criteria	*Description*	*Frequency*	*40 CFR Reference EPA QA Guidance*
Range Checks & Data Screening Criteria (EPA Suggested to Flag Data If:)			
Wind direction	Is <0 or >360 degrees	All data	EPA-454/R-99-005, Section 8.6, Table 8-4
	WD does not vary ≥1º/3 consecutive hrs.		
	WD does not vary ≥10º/18 consecutive hrs.		
Wind speed	Is <0 or >25 m/s		
	Doesn't vary >0.1m/s - 3 consecutive hrs.		
	Doesn't vary >0.5m/s - 12 consecutive hrs.		
Temperature	T <local record low, or >local record high		
	>5ºC change from previous hour		
	Doesn't vary > 0.5ºC for 12 consecutive hrs		
Barometric pressure	pressure >1060 mbar (sea level)		
	pressure <940 mbar (sea level)		
	pressure varies >6mb/3hours		
Relative Humidity (Dew Point)	Dew Point ≤ Amb. Temp. for time period		
	∆ Dew Point Temp. ≤5°C from previous hour		
	∆ Dew Point Temp. ≤0.5°C over 12 hours		
	Dew Point Temp. ≠ Amb. Temp. for 12 hours		
Calibrations			
All sensors calibrated by manufacturer	According to manufacturer specs	Every six months	EPA-454/R-99-005
WD alignment	WD alignment to true N verified by TSN		
Quality Control (QC) Checks - Visual inspections			
Wind speed sensor	Moving freely, no visual damage	Each site visit	EPA-454/R-99-005
Wind direction sensor	Moving freely, no visual damage		
Temperature sensor	No visual damage or obstruction		
Barometric pressure sensor	No visual damage or obstruction		
Relative humidity sensor	No visual damage or obstruction		
Time and Date DAS	DAS time/date agree with NIST time		
Assessments - Systems Audit			
Thorough review of entire monitoring system including field systems, data management, and data reporting.	In compliance with approved QAPP	1/year and <30 days of site start-up	EPA-454/R-99-005

Table B7: Meteorological Sensor Data Validation Table			
QA/QC Operational Evaluations			
Criteria	***Description***	***Frequency***	***40 CFR Reference EPA QA Guidance***
Audit Performance Evaluation			
Wind speed	±0.2 m/s ±5%	Semi-annually and ≤30 days of site start-up	EPA-454/R-99-005
WS bearing torque threshold	≤1.0 gm-cm		
Wind direction	±5 degrees		
WD linearity crossover	±3º (included in ±5º above)		
WD bearing torque threshold	≤11.0 gm-cm		
Temperature	±0.5° Celsius		
Relative Humidity-Dew Pt Temp	±7%, ±1.5° Celsius		
Barometric pressure	±3 mbar		
Systematic Issues			
Standard Reporting Units			
Wind speed	0 – 50 m/s	All data	EPA-454/R-99-005
Wind direction	0-360 degrees		
Temperature	-50 to +50 Celsius		
Relative Humidity-Dew Pt Temp	0 – 100% Humidity		
Barometric pressure	800 – 1100 mbar		
Assessments -Systems Audit			
Thorough review of entire monitoring system (field, lab, data, etc.)	In compliance with approved QAPP	Once per year and ≤30 days within site start-up	EPA-454/R-99-005

B6. INSTRUMENT / EQUIPMENT TESTING AND INSPECTION / MAINTENANCE

B6.1 System Delivery, Installation and Site Acceptance Tests

All furnished monitoring systems will be of turnkey design. The monitoring systems will be assembled at Enviroplan Consulting's assembly and test facility in Wayne, NJ. Received monitoring instruments and materials will be visually inspected for integrity and conformance with specifications. Monitoring system assembly will be performed by Enviroplan Consulting's trained and experience Monitoring Division technical staff in accordance with approved engineering documents. Monitoring equipment that satisfies visual inspection and conforms to purchase order specifications will be powered on and tested for correct operation, first as individual instruments and subsequently as integrated with other, related equipment.

Data acquisition system (DAS) software programming and configuration will be checked for conformance to defined functions, measurement ranges and other configuration parameters. DAS functions and scaling accuracy will be confirmed using known, NIST-traceable electrical test signal inputs as surrogates for monitor measurement signals. PC-based data application software will be configured to acquire, store, process the data and produce desired reports. Data transmission and acquisition functions between the data logger and the PC application software will be tested for proper operation.

During the assembly and test phase of the work, the Enviroplan Consulting Project Manager will review the status of equipment assembly and test results on a weekly basis. He will prepare and submit bi-weekly reports on the progress of this work to Ameren. He will inform Ameren of any problems or delays in the equipment test results or work progress that could impact the project schedule and document actions planned or taken to mitigate the problem.

B6.1.1 <u>Factory Test</u>

After the equipment is assembled and integrated as a complete system, the instruments will be calibrated in accordance with the approved QAPP and associated SOP and allowed to operate under conditions that closely approximate actual field operating conditions for several weeks. During this interval, comprehensive operating status checks will be performed and documented on each instrument undergoing testing at minimum two-day intervals. Data from the pollutant monitors will be continuously acquired and collected via the configured system DAS. Periodic calibration checks will be performed and results documented. The recorded test data will be reviewed by the technical staff to confirm correct, stable operation and that instrument performance conforms to the manufacturer's and engineering specifications.

Upon obtaining satisfactory initial performance test results, Enviroplan Consulting will perform additional, extended factory acceptance testing. Due to the nature of air quality monitoring instruments, long-term stability of operation cannot be assessed in a one-time performance/ calibration check. Consequently, we will incorporate the cumulative performance data recorded over several weeks of system operation at our facility into the factory acceptance test results. This provides a better representation of satisfactory system performance.

B6.1.2 System Delivery

Following factory acceptance tests, Enviroplan Consulting will ship to the shelter manufacturer who will protectively pack all equipment within the monitoring shelters for delivery to the Labadie Energy Center via flatbed truck. Where necessary, the manufacturer’s original cartons and packing materials will be used. The 8 foot-wide shelters are loaded on the truck bed such that there is no overhang.

Prior to shipping, the packaging will be clearly marked with contents and designation to permit ready identification and final installation. A detailed list of equipment in each shipment will be created to facilitate tracking of the shipment.

B6.1.3 Site Installation

Following satisfactory delivery, inventory and inspection of the monitoring system equipment at the Labadie Energy Center, Enviroplan Consulting will confirm scheduled monitoring site preparation and construction is complete, the shelters installed, electric service delivery and electrical grounding of the monitoring stations is complete. Two Enviroplan Consulting Senior Monitoring Engineers will then arrive on site as established in the equipment field installation work schedule to assist with monitoring system installation.

Installation will conform to the engineering documentation and approved QAPP. All wiring terminations will be carefully checked against the engineering documentation. Signal cables will be tagged at both ends for easy identification and all wiring will be neatly dressed and secured with weatherproof, UV-resistant cable ties. Work areas will be kept organized and tidy during the installation process. Waste material (typically corrugated cartons and packing materials) will be kept organized and properly disposed of in consultation with Ameren.

B6.1.4 Site Acceptance Tests

Following installation of the monitoring systems in the field, the system will be field-tested for proper operation and functional performance. Enviroplan Consulting's Monitoring Engineers will power-up the instruments and perform a documented check of component/systems operating functions to confirm the operational integrity of the installed monitoring systems. Operational integrity checks will include verifying:

- Correct functioning of each pollutant and meteorological monitor;

- Confirmation of correct monitor I/O signals and acquisition and recording of monitor I/O signals by each station data acquisition systems (DAS);

- Confirmation of automated and manual system control functions, including execution and recording of results of automatic calibration checks performed on each pollutant monitor;

- Correct functioning of all sample intake systems and shelter temperature control systems.

- Comprehensive checks of each station DAS and data transmission functions via the installed wireless data modems. This will include verifying correct automatic data transmission from each monitoring system, receipt and recording of the data by the central data management system, correct transmission and receipt of alarm conditions by the central data acquisition system and to designated recipients via automated transmittal of text and email messages, and verifying correct central data acquisition system functionality for remote interrogation of each station DAS the pollutant monitors installed at each station.

Upon confirming correct system functions and operating status, initial multi-point calibrations will be performed on each monitor using certified calibration standards and equipment traceable to the National Institute of Standards and Technology (NIST) in accordance with the approved QAPP and relevant SOPs. Initial calibration test data will be fully documented.

Meteorological measurement systems will be calibrated using standard calibration methods described in the EPA QA Handbook for Air Pollution Measurement Systems-Volume IV, Meteorological Measurement Systems ("Volume IV"). Calibrations of the monitoring instruments will be performed using calibration standards and equipment that are traceable to the NIST or other authoritative standard, as appropriate.

The keyed mounting base and cross arm for mounting the wind direction sensor will be carefully oriented along the True North-South azimuth axis using a surveyor's transit and correcting for the known magnetic declination of the site location. The calibration of the wind direction sensor and measurement system will then be checked utilizing the manufacturer's azimuth linearity test fixture and orienting the sensor to known azimuth headings every 30° of direction (30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300°, 330°, and 360°).

The horizontal and vertical wind speed measurement systems will be calibrated against a certified, variable-speed anemometer drive motor at a minimum of three simulated wind speeds.

Certified torque watches will be used to assess the starting torque of each wind sensor to ensure sensor starting thresholds conform to manufacturer's specifications.

Air temperature measurement systems will be calibrated against certified, NIST-traceable, partial immersion thermometers at three different temperatures using stable thermal masses.

Relative humidity measurement systems will be initially calibrated against the manufacturer's primary standards maintained at the manufacturer's factory. The initial calibration test data will be retained and archived for future reference. Startup calibrations and all subsequent field calibrations of these measurement systems will inter-compare data collected by the measurement system against data concurrently collected by a certified, collocated transfer standard (CTS).

Barometric pressure measurement systems will be initially calibrated against the manufacturer's primary standards maintained at the manufacturer's factory. The initial calibration test data will be retained and archived for future reference. Startup calibrations and all subsequent field calibrations of these measurement systems will inter-compare data collected by the measurement system against data concurrently collected by a certified, collocated transfer standard (CTS).

Solar radiation measurement systems will be initially calibrated against the manufacturer's primary standards maintained at the manufacturer's factory. The initial calibration test data will be retained and archived for future reference. Startup calibrations and all subsequent field calibrations of these measurement systems will inter-compare data collected by the measurement system against data concurrently collected by a certified, collocated transfer standard (CTS).

Precipitation measurement systems will be calibrated against the introduction of known volumes of water.

All site acceptance and calibration test data will be documented on forms developed by Enviroplan Consulting specifically for that purpose in accordance with the approved site acceptance test plan. The test data will be compared with respect to the manufacturer's stated specifications for accuracy and performance and compliance with the design requirements established for the monitoring project. The documented system calibration test data shall provide primary evidence of acceptable system performance.

B6.2 Routine Site Visits

Our local field operator will perform all routine, day-to-day operation and maintenance services for the monitoring stations in accordance with the regulatory guidelines and requirements applicable to the monitoring program. The field operator will be supported in this work by the experienced staff of Enviroplan Consulting's Monitoring Division. The following subsections describe the activities performed by the local field operator in support of network operation and maintenance.

During each routine on-site visit (minimum six-day intervals), the local network operator will carry out:

1) Routine instrument operational status checks; and

2) Routine quality control activities listed in Table B5.

Additional local operator responsibilities include performing:

3) Regularly scheduled preventive maintenance according to approved SOPs and manufacturer recommendations;

4) Periodic calibrations on the monitoring instruments at (minimum) semi-annual intervals;

5) Assisting in performing semi-annual meteorological audits and calibrations; and

6) On-site emergency equipment maintenance, repair or corrective actions as required.

The local field operator (and other Enviroplan Consulting personnel, when present at the network) will maintain documentation of all site visits through quality control and quality assurance documentation forms and a permanent logbook maintained at the monitoring site. Each entry will be dated and signed, and each instrument identified by make, model and serial number.

A copy of the approved Standard Operating Procedures (SOPs) and Quality Assurance Project Plan (QAPP) developed by Enviroplan Consulting for the ambient air monitoring program will be kept at the monitoring station. Operation of all monitoring equipment will be in accordance with the approved project QAPP and SOPs, Operation Manual provided by the equipment supplier, by any of the conditions of EPA equivalency or reference method designation, and in accordance with applicable MDNR APCP requirements.

B6.3 Preventive Maintenance

An on-site inventory of spare parts and expendables will be maintained within the monitoring stations. The spare parts stock is determined by the repair history for the monitoring equipment in use and manufacturer's recommendations, thus minimizing downtime of the instrument. For air quality monitors, sample pumps and other miscellaneous parts are maintained on-site as dedicated spare parts. For meteorological monitoring systems, complete spare wind speed and wind direction sensors are maintained on-site in the event of lightning damage or failure. Additional spare parts and modules, including complete replacement instruments, are maintained at Enviroplan Consulting's headquarters in Wayne, NJ.

B6.4 Corrective Maintenance

Enviroplan Consulting will provide technical support to our local field operator to assist as-needed in identifying and resolving the cause of any problem. During the course of the monitoring program, the Project Manager, network Field Operator, QA Coordinator and Data Manager are responsible for ensuring that all measurement procedures are followed as specified in this QAPP and that measurement data meet the prescribed acceptance criteria. Prompt action must be taken to correct any problem that may arise.

Quality control problems requiring major corrective action will be documented on a Non-Conformance/Corrective Action (NC/CA) Report. <u>Some</u> examples of events warranting the generation of an NC/CA report are:

- Monitoring system QA/QC control or acceptability limits exceeded.
- Monitoring equipment and/or support equipment malfunctions.
- Shelter temperature control range exceeded (air conditioner, thermostat, etc.).
- Improper procedures used during calibrations or operations.

- Power outages.

NC/CA reports generated by network operators will be included with routine data submittals to the Data Manager. Supervisory or other staff that generate NC/CA reports should ensure the Data Manager is provided with a timely copy. Each report will clearly identify:

- a concise description of the problem;
- assessment of data validity/operations impact;
- manufacturer, model number and serial number of malfunctioning instrument;
- parameter(s) affected and a preliminary indication of data status (e.g. valid, suspect or invalid);
- the start and end times and date(s) of the problem;
- all actions taken to restore the system to normal operation;
- corrective action required to return the instrument to operational status and identification of person(s) responsible for resolving the problem; and
- when the personnel became aware of the problem.

Each report must be initialed and dated by the originator (e.g. network operator). Each NC/CA Report also requires the QA group to respond and verify that the corrective action has been implemented. Control limits and prescribed corrective action related to the various internal QC checks are discussed in Appendix C, Standard Operating Procedures of this QAPP.

B6.5 Routine Data Management and Response to Out-of-Control Alarm Conditions

Enviroplan Consulting will establish and maintain individual, broadband wireless data service accounts with Verizon Wireless in support of maintaining data telemetry and communication services for each of the monitoring stations. These accounts will be established during the factory test phase of the project to enable testing and verification of data transmission and communications between each monitoring station and the Central Data Management system located in Wayne, NJ.

Additionally, on each business day, a data technician at Enviroplan Consulting's central data management center in Wayne, NJ will review the previous day's monitoring data for reasonableness and completeness. The data record will also be manually checked for any fault or alarm conditions regarding monitor system operating status. Results of automatic, daily Level 1 zero/span checks and weekly one-point quality control checks on pollutant monitors are also reviewed against calibration control limits each business day. If a monitor’s response to an automated calibration check exceeds established control limits, the field operator will be instructed to visit the station within 24 hours to investigate the cause of the problem and perform corrective actions as necessary. This may include manual performance and documentation of an unscheduled one-point quality control and Level 1 zero/span check on the monitor(s) followed by maintenance and adjustment (if indicated) to ensure the data produced by the monitor is consistent with the goals and requirements established for data accuracy, precision, and bias.

These operation and maintenance support services will ensure the minimum valid data recovery rates established for the monitoring project are consistently met (and typically exceeded). Similar monitoring programs conducted by Enviroplan Consulting consistently achieve data collection efficiencies of 95% and more. Consequently, we are confident that our operation of the monitoring project will achieve and maintain a 95% or higher valid data recovery rate.

B6.6 Spare Parts

An on-site inventory of spare parts and expendables will be maintained within the monitoring stations. The spare parts stock is determined by the repair history for the monitoring equipment in use and manufacturer's recommendations, thus minimizing downtime of the instrument. For air quality monitors, sample pumps and other miscellaneous parts are maintained on-site as dedicated spare parts. For meteorological monitoring systems, complete spare wind speed and wind direction sensors are maintained on-site in the event of lightning damage or failure. Additional spare parts and modules, including complete replacement instruments, are maintained at Enviroplan Consulting’s headquarters in Wayne, NJ. Table B8 lists the spare parts that are recommended to be maintained for the continuous gaseous analyzers in the monitoring network.

Table B8: List of Spare Parts and Expendables

Part Number	Description	Qty.
TAPI Model T100 SO_2 Analyzer		
061930000	UV Lamp Driver	1
009690100	Teflon Filter Element, 47mm, 30 pack	1
018080000	Dessicant Baggies, (12)	1
FL0000001	Filter, SS	2
PU0000022	Rebuild Kit for KNF Pump	1
TAPI Model T700 Dilution Calibrator		
056440000	2-way Cylinder Port Valve	1
022710000	Absorption Tube, Quartz	1
TAPI Model 701E Zero Air Supply		
FL0000007	Filter, Coalescing, .03 Micron	1
005960000	6lbs Act Charcoal (2 Bt=1)	1
005970000	6lb Purafil (2bt=1)	1
006900000	Retainer Pad Charcoal, Small, 1-3/4"	4
006900100	Retainer Pad Charcoal, Large, 2-1/4"	4
016920000	Mol Seive	1
057270000	Gasket, Scrubber	4
FL0000016	Filter Element, Paper, For Fl15	2

B7. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Instrument calibration and frequency are discussed in this section, with additional information available in Appendix 4 (the method-specific data validation tables). Thorough details on instrument calibration are provided in the instrument standard operating procedures in Appendix 9.

B7.1 Calibration Equipment for Air Quality Monitors

Routine calibration, one-point quality control and Level 1 (zero/span) data validation checks on the continuous gaseous pollutant analyzers will be performed at minimum 24-hour intervals using an in-station calibration system. The in-station calibration system will consist of cylinders of compressed standard gas, a zero air generator and a gas dilution calibrator equipped with precision mass flow controllers for controlling programmed flow rates of calibration standard gas and diluent ("Zero") air. The dilution calibrator will be calibrated and certified at (minimum) 6-month intervals using a primary flow standard. Calibration and certification will be performed in accordance with relevant guidance contained in U.S. EPA Quality Assurance Handbook for Air pollution Measurement Systems.

B.7.1.1 Calibration Gas Standards

Cylinders of compressed calibration standard gases will be maintained at each monitoring station employing gaseous pollutant analyzers. The stationary cylinders will be secured in the exterior cabinet attached to each shelter using an approved restraint system. Calibration gas cylinders are typically sized to contain a volume of gas commensurate with the EPA Protocol Certificate of Traceability at normal consumption rates. The compressed gas standard will be obtained from a qualified vendor and the concentrations of the gas blend will be assayed and certified at the time of manufacture in accordance with U.S. EPA Protocol G-1. The constituent components and associated approximate concentrations of the compressed calibration gas standard will be 50 ppm SO_2. The balance gas for the standard gases will be UHP nitrogen (N_2). High-purity, stainless steel, dual-stage regulators will be furnished and used to deliver standard gas from each cylinder to the dilution calibrator. Tubing and fittings used for delivery of calibration gases will be of FEP Teflon and/or stainless steel.

B.7.1.2 Zero Air Supply

A Teledyne-Advanced Pollution Instruments (TAPI) Model 701 Zero Air Generator capable of continuous delivery of clean, dry, pollutant-free air will be supplied for the monitoring station. The Model 701 utilizes a long-stroke pump that allows for an output capacity of 10 SLPM at 35 psig without any restriction. The fittings within the 701 are all clean stainless steel in order to reduce the possibility of contamination. The 701 has a shuttle valve integrated into the header of the regenerative drier to increase its ability to consistently deliver dry air, and utilizes a dew point sensor that will indicate a warning signal when the output dew point exceeds -16ºC. Additionally, the Model 701 features a high-performance, heated catalytic hydrocarbon & CO scrubber, a Purafil canister, and an activated charcoal canister, an additional CO scrubber prior to the output of the instrument to eliminate any natural out-gas of CO from the activated carbon.

The output air stream of the Model 701 contains less than 0.25ppb of SO_2, NO, NO_2, O_3, VOC and CO, even when input air stream contains levels of these pollutants as high as double the OSHA permissible exposure limit (PEL). The dew point of the output air stream is < -25ºC at 20 SLPM and ≤ -30ºC at 5 SLPM.

B.7.1.3 <u>Gas Dilution Calibrator</u>

A TAPI Model T700 gas dilution will be furnished and operated at each monitoring station employing gaseous pollutant analyzers. The Model T700 incorporates a microprocessor to provide a menu-driven user interface and has the capacity to electronically store automated calibrator functional routines and other information entered by the user.

The gas dilution calibrators feature selectable inputs for up to four different compressed gas standards and one input for dilution, or “zero” air. Separate mass flow controllers (“MFCs”) are used to independently set and control mass flow rates for the gas from the compressed gas standard and the zero, or dilution, air supply. Test gas atmospheres of a known concentration of the pollutant gas of interest are dynamically produced by combining the accurately known and stable mass flow of the concentrated calibration standard gas with an accurately known, stable mass flow of zero air (i.e., an air stream from which all pollutants and other potential contaminants or interferents have been removed). The two flows are combined to create a homogeneous stream of calibration gas that is delivered to the analyzer(s) at or close to atmospheric pressure.

To produce test gas atmospheres of known concentration, the mass flow rates of the gas standard and zero air must be accurately known and precisely controlled. Up to five different flow rates for each MFC can be pre-set and remotely activated. Similarly, up to five different GPT mode levels can be pre-set and remotely activated. Each of the referenced calibrators includes provision for remote activation and control of all operating modes via inputs located on the rear apron of the instrument. The TAPI T700 calibrators will be integrated with the other monitoring system components to perform automatic, multi-point calibrations on the pollutant monitors at defined times and repetition intervals.

The calibration of all MFCs will be referenced to standard reference conditions (SRC) for temperature and pressure. The U.S. EPA defines SRC as 25ºC (298.15 degrees Kelvin) for temperature and 760 millimeters of mercury (mmHg) for pressure. MFCs inherently measure and regulate fluid (gas) flow at a mass flow rate.

For the TAPI T700 calibrator, the effective range of flow rates available for zero air is 1 to 10 standard liters per minute (SLPM). The effective range of flow rates available for gas is 10 to 100 cubic centimeters per minute (sccm). This range of flow rates permits accurate dilution ratios as low as 10:1 and as high as 1,000:1 to be achieved. Calibration of the MFCs will allow production of flow rates across the range with an accuracy of ≤ ±2% of reading.

The semi-annual calibration of each MFC in the calibrator will reference the known mass flow rate to the reported mass flow rate of each MFC. This convention will maintain traceability of automatic calibration checks activated and controlled via interface of the calibration system with the on-site DAS, because the MFC reported mass flow rate will be acquired, scaled and reported by the DAS in accordance with the current calibration relationship established for that MFC during each step of the automatic calibration test gas generation cycles.

By measuring and reporting the flow rates for gas and air during each automatic calibration sequence, and by knowing the certified concentrations of the compressed gas standard maintained at the monitoring site, the actual concentration of the test gas delivered to the analyzers will be accurately known and verified along with the corresponding analyzer responses. This approach maintains NIST-traceability of the calibration checks activated and controlled by the on-site DAS.

B.7.2 Calibration Equipment for Meteorological Monitors

The meteorological monitoring system will be calibrated at the time of station startup and at minimum semi-annual intervals thereafter. Calibration equipment for the meteorological monitors will be certified against NIST-traceable standards at minimum annual intervals, as appropriate. The meteorological calibration apparatus will include:

- Certified variable speed or synchronous anemometer drive motor(s) with an accuracy of ±1 RPM at (minimum) 300, 600 and 900 RPM.

- NIST-traceable digital voltmeter with 0.001volt resolution and an accuracy of ±0.05% of input ±1 digit.

- Climatronics Model 107040 Azimuth Linearity Test Fixture.

- NIST-traceable torque measurement devices with a minimum accuracy of ±5% of reading over a range of 0.2 to 2 gm-cm and 3 to 24 gm-cm (e.g., Waters Torque Watch Models 366-3M and 366-1M).

- Climatronics keyed-mount sighting scope or surveyors transit to assess orientation of the wind direction sensor relative to True North.

- Compass and/or True Solar Noon times for audit dates for site location and accurate timepiece.

- Certified, NIST-traceable temperature standards with a minimum accuracy of ±0.1^{o}C of reading and covering a temperature range of 0^{o}C to 50^{o}C with 0.05^{o}C resolution.

- Reference psychrometer with a minimum accuracy of ±3% and covering a range of 0 to 100%.

- Reference pressure standard with a minimum accuracy of ±0.3mb over a range 0f 500 to 1200mb.

- Reference burette with adjustable stopcock having a known volumetric accuracy of ±2% and a minimum capacity of 25ml.

- WMO-calibrated collocated transfer standard (CTS) for solar radiation measurement

B8. INSPECTION/ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

For the air quality continuous analyzers and the meteorological sensors, spare parts (see Section B6) may be purchased from the manufacturer of the instrumentation. Information including addresses and telephone numbers for ordering spare parts are included in each instrument's manual. Generic spare parts may be accepted, if appropriate. The spare parts will be inspected for shipping damage upon receipt. Routine replacement parts will be kept on-site to minimize monitoring instrument down time. Replacement parts may also be kept at the air monitoring contractor's office. Other parts will be ordered from the analyzer manufacturer using overnight shipping, if necessary.

Spare parts for the continuous gas analyzers, particulate matter samplers and the meteorological sensors are maintained and stored inside the air monitoring shelter. These spare parts include, but are not limited to, pump rebuild kits, various replacement filters, analyzer solenoid valves, a spare sampling inlet, zero air scrubber materials, pump muffler, various O-rings and other spare sensors and recommended parts.

Since instrument calibrations are required following the installation of any spare parts, the use of any spare parts will be documented on the calibration form. Enviroplan Consulting field operations manager will be responsible for the acquisition and installation of spare parts, and ensuring that the proper procedures are followed after spare part installation. Generally this procedure includes performing an as-found calibration, maintenance, then an as-left calibration. Certification of key spare parts will be ensured by ordering these exclusively from the analyzer manufacturer. Purchasing records (log) for spare parts are kept in the files at the Enviroplan Consulting's office.

B9. NON-DIRECT MEASUREMENTS

The monitoring program does not require the use of data from non-measurement sources. In order to assist in data review and data validation, data from non-measurement sources may be used as a comparison against collected data.

The closest first-order National Weather Service (NWS) station is the St. Louis Lambert International Airport, NWS Station KSTL. This station is located about 45 km to the east-northeast of the Labadie Energy Center and provides the most comprehensive record of climatologic data for the region that is considered to be representative of conditions in the site area.

Data from outside sources used for purposes of data review will not be used to substitute any missing data collected in the monitoring program.

B10. DATA MANAGEMENT

Data collection will commence immediately following completion of site acceptance test calibrations. All data handling procedures and data validation techniques will meet the relevant regulatory guidelines. Archival of the data will be made by Enviroplan Consulting for a maximum of 5 years, at which time final disposition will be determined in consultation with Ameren.

All continuous data from the monitoring station will be retrieved from the station DASs on a daily basis. A dedicated work station PC located at Enviroplan Consulting's Data Management Center in Wayne, NJ will automatically interrogate each station DAS and download the requested data files via dedicated wireless data transmission service accounts established and maintained by us for each monitoring station. Each business day a data technician will check the data files to ensure that all data were successfully transmitted and stored in the PC. The central data management software will automatically re-poll any site to backfill any missing data files. If data are still missing, they will be manually retrieved.

All data handling procedures and data validation techniques will meet the relevant criteria and guidelines contained in 40CFR Part 50 for National Ambient Air Quality Standards (NAAQS) and 40CFR Part 58 Appendix A for reporting of air quality monitoring data. Data review is performed each workday to monitor instrument operations and to ensure the data have been properly formatted for further evaluation. Manual reviews of the data use graphic analysis to spot any unusually high or low values (outliers), or to detect uncorrected drifts in the baseline of a meteorological sensor. Additionally, comparisons of the redundant systems are incorporated with the daily data checks. Any suspected data is flagged for further evaluation and brought to the Project Manager's attention immediately. Any corrective actions are noted on the appropriate checklists and forms.

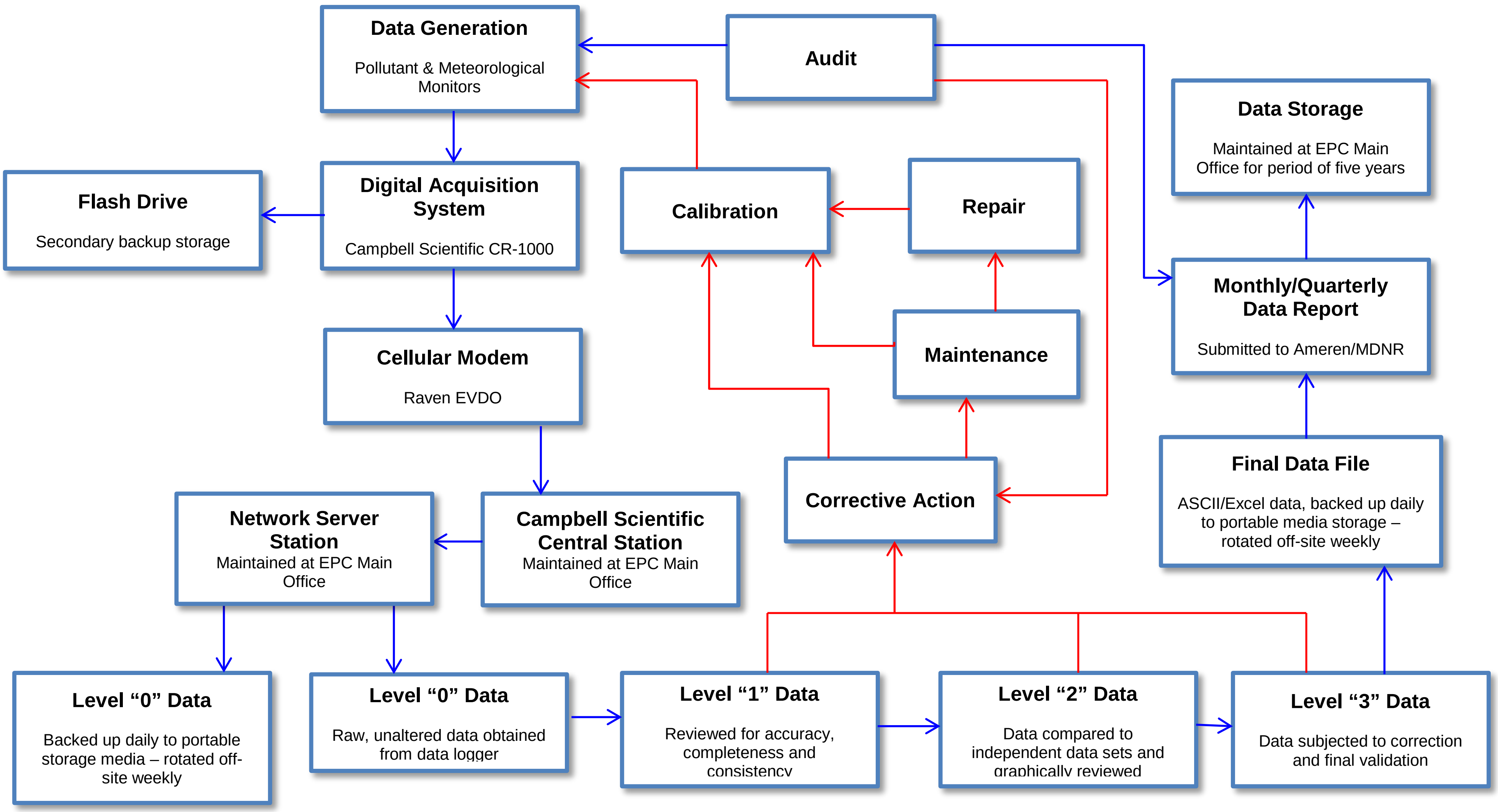
The monitoring system is designed to fully automate calibration checks of all gaseous pollutant monitors. The calibration system design allows the on-site DAS to record the actual flow rates of calibration standard gas and dilution air through the mass flow controllers within the on-site dilution calibrator, as well recording the stability of associated monitor measurement response, thereby ensuring automatic calibration check results are fully defensible, traceable to National Institutes of Standards and Technology (NIST) and directly usable for data validation and data precision and bias reporting requirements.

In addition to monitoring shelter interior temperature, the monitoring system continuously monitors and records the electrical power status delivered to the site.

The on-site DAS will also continuously acquire, store and transmit all internal operating status information from each pollutant monitor. The logged internal operating status information allows for review of historical monitor internal operating condition data to identify and troubleshoot any out-of-control conditions and also real-time, remote communications directly with any pollutant monitor are available. This is tool will be utilized as-needed to rapidly diagnose and resolve any monitoring system malfunctions.

All other documentation pertaining to this project (e.g., site checklists, audit and calibration forms) are reviewed upon receipt to ensure that all forms are completed prior to acceptance and for further use in this project. Figure B24 presents a flow chart which describes the project data management process and traces the path from data generation through data use and storage, including control mechanisms for detecting and correcting errors and audits of data for the ambient air analyzers, and meteorological monitors. Data review, validation and verification methods are discussed in detail in Section D.1. Table D1 summarizes the data review for this monitoring project.

Figure B24: Data Management Flow Chart



SECTION C: ASSESSMENTS AND OVERSIGHT

C1. ASSESSMENTS AND RESPONSE ACTIONS

The independent audit program for the ambient air and meteorological monitoring program consists of systems and performance audits. The performance audits and systems audits are conducted by Enviroplan Consulting audit personnel, who are independent of the staff operating the monitoring network and are conducted using equipment independent of that used routinely in the monitoring network.

The audit criteria are summarized in the data validation tables in Appendix 4. SOPs for conducting these audits are included in Appendix 9. Supporting audit forms are included in Appendix 8.

C1.1 Audit Frequency and Personnel

Performance and systems audits of the gaseous pollutant analyzers are routinely conducted at quarterly intervals on each operating analyzer. Performance and systems audits of the meteorological field measurement systems are routinely conducted at semi-annual intervals. Audits of meteorological field measurement systems are performed under the supervision of the Enviroplan Consulting Quality Assurance Coordinator by a person(s) familiar with the methods, procedures and objectives established for the meteorological monitoring project, but not directly involved with routine network operation and maintenance and performance of quality control checks. A technical systems audit on the gaseous pollutant analyzers and the meteorological measurement system will also be conducted within 90 days of the beginning of sampling.

C1.2 Systems Audits

Systems audits are independent assessments of the accuracy and procedures employed in operation of the field measurement systems and associated data quality. Audit results are used to evaluate the ability of the system to produce data that fulfill the objectives established for the program, satisfy the quality control criteria, and identify any areas requiring corrective action. A systems audit is a qualitative review of the overall measurement system, while performance audits are a quantitative assessment of the accuracy of a measurement system.

Shortly after the completion of a systems and/or performance audit, a debriefing session is held for all participants to discuss the preliminary audit results. The auditor then completes the audit evaluation and submits an audit report, including observations of strengths and deficiencies, and recommendations for improvements. All observations are documented, and the completed audit forms are submitted, along with the auditor's assessment and recommendations, to the QA Coordinator, Project Manager, Data Manager and other participants as appropriate. Formal recommendations for corrective actions will be made if systematic problems are found that will impact general data quality and the overall achievement of the project objective(s). The systems audit summary and results become part of the project QA record and associated reports.

C1.3 Performance Audits

Performance audits quantitatively assess the accuracy of the data produced by a measurement system by assessing the monitoring system's response against known test inputs. Performance audits of meteorological monitoring systems involves assessing the monitoring system's response against known test inputs or test conditions (sensor control test methods) or statistically comparing the data produced by the monitoring system against corresponding data produced by a collocated transfer standard (CTS test method).

The performance audit answers questions about whether the measurement system is operating within control limits and whether the data produced meet the project quality assurance specifications established for data accuracy.

Performance audits are conducted using independent calibration standards and equipment that are not used for routine calibrations or QC checks of the measurement systems. The standards and equipment used for performance audits will be currently calibrated or certified and referenced to NIST-traceable or other authoritative standards, as applicable. It is permissible for audit standards to be calibrated or certified against the same primary standards as are used to calibrate or certify the equipment used for routine network calibrations and QC checks of the measurement systems.

Subsequent to initial startup calibrations, performance audits will be conducted on the meteorological measurement systems at semi-annual intervals. Performance audits of the meteorological systems will be conducted by standard calibration methods based on procedures described in the "Quality Assurance Handbook for Air Pollution Measurement System: Volume IV. Meteorological Measurements Version 2.0 (Final)" EPA-454/B-08-002, March 2008 (herein after referred to as Volume IV).

C1.3.1 <u>Gaseous Pollutant Analyzer Audits</u>

During each calendar quarter, each gaseous pollutant monitor will be audited at least once. A quality assurance audit report will be generated within 10 days after completion of each audit. The results of this report are forwarded to the Enviroplan Consulting Project Manager for review. The Project Manager will ensure appropriate action is taken with regard to the audit results and recommendations. The audit results will be incorporated in the quarterly quality assurance data reports produced by the Enviroplan Consulting Data Manager and used as the basis for quarterly accuracy assessments of the data reported from each gaseous pollutant analyzer operated in the network.

Gas analyzers will be audited while operating in their normal sampling mode, with the audit test gas passing through all filters and components used during normal sampling operations and as much of the sampling system inlet line as practical. The auditor will record the audit results, date and initials in the site logbook and also on standard audit report forms. The auditor will document the "Start" and "End" times for the audit of each instrument and, prior to beginning the audit, enter the appropriate information in the on-site data acquisition system (DAS) so that appropriate status flag(s) will be appended to all data collected during the audit test interval. Following completion of the audit, the auditor will restore the monitoring system to normal operating (sample) mode and enter the appropriate information in the on-site DAS so that normal data collection resumes.

Audit calibration standard gases will be traceable to NIST Standard Reference Material (SRM) by means of direct comparison according to Procedure G-1 of the EPA Traceability Protocol. Audit gases for SO_2 analyzers will be supplied from a blended cylinder of compressed standard gas containing approximately 50ppm of SO_2 in oxygen-free Nitrogen (N_2).

Enviroplan Consulting's Quality Assurance Section uses a Teledyne API T-700 gas dilution system for auditing continuous SO_2 monitors. Calibration and certification of the audit calibrator is performed at 6-month intervals against NIST-traceable primary standards at our QA Laboratory in Wayne, NJ.

A November 10, 2010 memorandum from the U.S. EPA supported expansion of allowable audit ranges and for the selection of non-consecutive audit levels while still auditing a minimum of three audit levels. The independent audit of gaseous pollutant analyzers for the monitoring program will consist of challenging the analyzers with a zero test gas and at least three upscale audit gas of known concentration within each of the following ranges:

Table C1: Continuous Gas Analyzer Audit Concentration Ranges

Audit Point	SO_2 Concentration Range (ppm)
0	0.000
1	0.0500 – 0.0999
2	0.1500 – 0.2599
3	0.2600 – 0.7999

The acceptability of each analyzer's responses to each accuracy audit test point will be evaluated by determining the difference, in percent, of the analyzer's stable response to each test gas concentration in comparison to the known, true value ($\Delta\%$) of the test gas concentration. This value will be evaluated against the relevant QA audit acceptance criteria called out in Table B6 and the measurement data accuracy objectives established for the air quality monitoring program called out in Table B6.

The personnel, standards, and equipment used to perform the audit will be completely independent of those used for normal network operation. Requests by qualified outside parties, such as the MDNR, to conduct an audit of the monitors will be accommodated provided adequate advance notice (~ 2 weeks) is provided.

C1.3.2 Meteorological Sensor Audits

Performance audits will be conducted on the meteorological monitoring systems at semi-annual intervals.

The performance audit of all wind speed measurement systems will use the MSI method described in Section 2.7.2 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of imparting a controlled rate of rotation on the impeller shaft via a calibrated direct-current motor to simulate selected wind speeds. The starting threshold of the anemometer will be assessed with a torque watch.

The performance audit of wind direction system will use the sensor control method described in Section 2.7.3 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method describes the relative performance of the wind vanes as a shaft-position transducer and the orientation of the transducer with respect to true north. The former is done with a fixture, part of which is mounted to the transducer body and part is mounted to the shaft in place of the vane. The latter requires the determination of true north (MSI method SN008) and a setting of the transducer relative to the orientation.

The performance audit of the air temperature measurement system will use the sensor control method as described in Section 3.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of immersing the temperature probe and audit transfer standard(s) into stable thermal masses (i.e., insulated water baths) at three different temperatures: and ice slurry, an “ambient” bath and a hot bath.

The performance audit of the precipitation measurement system will use the sensor control method as described in Section 4.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This test method consists of challenging the gauge with amounts of water known to an accuracy of one percent of the total used. Using the manufacturer’s transfer function for the gauge, the equivalent amount of rainfall can be calculated and compared to the measurement system’s indication. This method determines the measurement system accuracy but not the collection efficiency of the gauge in natural precipitation. For tipping bucket gauges, a rate of less than one inch per hour will be used and an amount which will result in a minimum of 10 tips.

The performance audit of the relative humidity system will be made using the Collocated Transfer Standard (CTS) method described in Section 5.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the relative humidity sensor of the system under test and obtaining a series of comparison measurements over time (typically over the course of several hours). The average difference is the reported system error.

The performance audit of the solar radiation system will be made using the Collocated Transfer Standard (CTS) method described in Section 6.9 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the pyranometer of the system under test and obtaining a series of comparison measurements over time (typically a full diurnal cycle). The average difference is the reported system error.

The performance audit of the barometric pressure system will be made using the Collocated Transfer Standard (CTS) method described in Section 7.6 of Volume IV of the U.S. EPA Quality Assurance Handbook. This method consists of placing the audit CTS in close proximity to the barometric pressure sensor of the system under test and obtaining a series of comparison measurements over time (typically over the course of several hours). The average difference is the reported system error.

Personnel, standards, and equipment used will be completely independent of those used for routine operations. A quality assurance audit report will be generated following completion of each meteorological audit. The results of this report are forwarded to the Enviroplan Consulting Project Manager. The Project Manager will ensure appropriate action is taken with regard to the audit results and recommendations.

C1.4 Corrective Actions

All deficiencies and concerns identified during audits, site visits, and/or during data review will be recorded and reported to the Project Manager within seven working days of discovery. Any participant in the monitoring program may initiate a corrective action, if needed. Corrective actions to deficiencies will be addressed and documented in a Corrective Action form and in the audit reports. Any corrective actions will also be discussed in the annual data reports. All corrective action forms are reviewed by the Enviroplan Consulting Project Manager and as necessary, reported to the Ameren Project Manager for their review.

Each business day, data technicians at Enviroplan Consulting's central data management center in Wayne, NJ review the previous day's monitoring data for reasonableness and completeness. The data record will also be manually checked for any fault or alarm conditions regarding monitor system operating status. Results of automatic, daily Level 1 zero/span checks and weekly one-point quality control checks on gaseous pollutant monitors are also reviewed against calibration control limits each business day. If a monitor’s response to an automated calibration check exceeds established control limits, the field operator will be instructed to visit the station within 24 hours to investigate the cause of the problem and perform corrective actions as necessary. This may include manual performance and documentation of an unscheduled one-point quality control check and Level 1 zero/span check on the monitor(s) followed by maintenance and adjustment (if indicated) to ensure the data produced by the monitor is consistent with the goals and requirements established for data accuracy, precision, and bias.

Documentation of a suspected or actual non-conformance event (i.e., problem) is immediately initiated by the project team member who first identifies the event or condition. Non-conformance events may be identified by our automated data screening software or by a data technician in our Data Management Center during the course of routine manual data review, or by the local field operator during the course of a routine site check.

Documentation of a suspected or actual non-conformance event may be added to over time as investigative and corrective actions are taken. The documentation for such events includes all relevant information necessary to fully identify, characterize and assess the impact of the event or condition on monitoring operations and data validity. The monitoring site where the event occurred, event "Begin" and "End" times, model(s) and serial number(s) of affected equipment, and impacted monitoring parameter(s) are all identified, as are the names of each project team member who may contribute to the documentation record and/or is involved in investigating and resolving the problem. Documentation of non-conformance/corrective action events is archived as a permanent part of the monitoring program record, and is referenced during the data validation process.

C1.5 QAPP Revisions

When needed, this QAPP may be revised. Based on the review of the systems audit, or for other reasons, it may be necessary to revise this QAPP. The QAPP revisions will address any project deficiencies stated in the system audit. The project manager will make any necessary changes and the revised QAPP will be submitted to MDNR for approval. Complete, approved revisions will be distributed according to Table A1, QAPP Distribution List.

C2. REPORTS TO MANAGEMENT

Enviroplan Consulting will submit monthly and quarterly reports of the air monitoring data collected during the most recent, previous reporting period to Ameren. Quarterly reports of the air monitoring data collected during the most recent, previous reporting period to the MDNR APCP. All hourly-averaged, validated SO_2 and meteorological data will be submitted to Ameren and the MDNR APCP within 60 days following the end of each quarterly reporting period. Each quarterly data report will be submitted both as an electronic file in PDF or Excel format. The data listings will be reported in U.S. EPA AQS format on hardcopy and on the CD.

Each monthly data report will include a missing data report that lists all missing data by parameter, the hours affected and an explanation of the reason why the data are reported as missing or invalid. Invalid data are not included in any of the summary statistics.

The information reported for each monitoring station will include:

- Sequential, hourly listings (hard copy, tabular form and in U.S. EPA AIRS format on a data CD) of validated hourly gaseous and particulate pollutant and meteorological data (hard copy, tabular form and on a data CD in U.S. EPA AQS format);

- Concentration summaries for all measured pollutants, including year-to-date, highest and second-highest hourly block averages;

- Three-hour rolling averages of SO_2 data, including highest and second-highest values;

- Daily maximum hourly average of SO2 data;

- The maximum 5-minute SO2 concentration recorded for each hour;

- Meteorological data summaries on a monthly, quarterly, and annual basis including: average, maximum and minimum wind speeds, and joint frequency distributions of wind speed and wind direction (tabular and as wind roses);

- Comparison of measured pollutant concentrations with applicable National Ambient Air Quality Standards in units consistent with those criteria. Exceedances of the respective standards, if any, will be identified and discussed in a separate letter report.

The content of each quarterly data report will include tabular data averages for each month (as described for the monthly data reports above as well as:

- Relevant calibration, precision, bias and accuracy data and statistics;
- Data recovery rates and explanations of missing data periods; and
- Results from independent performance and systems audits.

The results of monitor performance checks are presented in an appendix to the monitoring data report. They are presented in tabular form and discussed with respect to conformance with applicable precision, bias and accuracy objectives along with the conventions used for calculating these parameters. Monthly and quarterly data recovery rates and explanations of missing data periods will also be summarized. Finally, the quarterly QA data report will contain copies of the various quality assurance check forms completed during the current reporting period (i.e., calibration data, Level 1 zero/span and one-point quality control checks and independent performance and systems audits).

SECTION D: DATA VALIDATION AND USABILITY

D1. DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

All data handling procedures and data validation techniques will meet the relevant criteria and guidelines contained in 40CFR Part 50 for National Ambient Air Quality Standards (NAAQS) and 40CFR Part 58 Appendix A for reporting of air quality monitoring data. Data review is performed each workday to monitor instrument operations and to ensure the data have been properly formatted for further evaluation. Manual reviews of the data use graphic analysis to spot any unusually high or low values (outliers), or to detect uncorrected drifts in the baseline of a meteorological sensor. Additionally, comparisons of the redundant systems are incorporated with the daily data checks. Any suspected data is flagged for further evaluation and brought to the Project Manager's attention immediately. Any corrective actions are noted on the appropriate checklists and forms. Data review, validation and verification methods are discussed in detail in Section B.10.

The monitoring system is designed to fully automate calibration checks of all gaseous pollutant monitors. The calibration system design allows the on-site DAS to record the actual flow rates of calibration standard gas and dilution air through the mass flow controllers within the on-site dilution calibrator, as well recording the stability of associated monitor measurement response, thereby ensuring automatic calibration check results are fully defensible, traceable to National Institutes of Standards and Technology (NIST) and directly usable for data validation and data precision and bias reporting requirements. Out-of-control calibration check results will be brought to the Project Manager's attention immediately.

The on-site DAS will also continuously acquire, store and transmit all internal operating status information from each pollutant monitor. The DAS software and hardware package allows easy review of historical monitor internal operating condition data and also real-time, remote communications directly with any pollutant monitor. This is tool will be utilized as-needed to rapidly diagnose and resolve any monitoring system malfunctions.

All other documentation pertaining to this project (e.g., site checklists, audit and calibration forms) are reviewed upon receipt to ensure that all forms are completed prior to acceptance and for further use in this project. Table D2 summarizes the data review for this monitoring project.

D1.1 Data Acquisition and Transmission

All continuous data from the monitoring station will be retrieved from the station DAS on a daily basis. Dedicated primary and secondary work station PCs located at Enviroplan Consulting's Data Management Center in Wayne, NJ will automatically interrogate the station DAS and download the requested data files via a dedicated wireless data transmission service account established and maintained by us for the monitoring station. Each business day a data technician will check the data files to ensure that all data were successfully transmitted and stored in the data base. The central data management software will automatically re-poll any site to backfill any missing data files. If data are still missing, they will be manually retrieved. This data is the raw data collected from the data logger and is considered “Level 0” data. These data are used to monitor instrument operations on a regular basis but are not used for reporting until subject to further review and validation. Level 0 data files are kept intact and unedited. These data are not subject to reduction or reformatting.

D1.2 Data Validation

This section summarizes the data processing and validation activities that will be implemented to meet the data quality objectives. These activities work in tandem with the quality assurance program discussed in Section B6 to ensure that valid and defensible data are obtained and reported.

D1.2.1 Level 1 Data Review

The raw data are screened using proprietary data quality control software and reviewed for reasonableness and completeness. The raw data are designated as “Level 1” data; that is, data for which no validation review has yet been performed. Initial (daily) review of the data will occur no more than four days after sample acquisition because of weekends and holidays. Daily data review includes checking for status or event flags, reasonableness of reported averaged data values (out-of-range, inconsistent or excessive transition values) and any missing data periods. The monitoring station internal temperature data are reviewed for conformance with U.S. EPA requirements for air quality monitor operation. Meteorological data are reviewed for agreement with local seasonal and prevailing conditions and internal consistency. Suspect meteorological data will be compared against data reported from the nearest National Weather Service station. Table D1 presents Meteorological Data Screening Criteria that are used in the data quality control software.

The results of automatic daily calibration checks and weekly one-point quality control checks for each gaseous pollutant monitor will be reported and evaluated by the on-site DAS against control limits established for analyzer calibration drift, thereby supporting “Level 2” validation of the data and providing a basis of decision for investigative actions, analyzer adjustment and calibration.

The data technician will annotate a separate data file created by the central DAS software and produce a summary report of any suspect data or out-of-tolerance operating conditions. Any situation requiring investigative and/or corrective action will be immediately brought to the attention of the Field Operations Supervisor and Network Operator. A “Non-Conformance / Corrective Action” (NC/CA) report documenting all pertinent information regarding the suspect data, non-conformance event or out-of-tolerance operating condition will be generated and updated with further information as it becomes available until the problem is fully resolved. Electronic files of the raw data record are archived "as is"; the central Data Management Department software will not permit any alteration of the raw data files under any circumstances. All further data processing, editing and validation work is accomplished by working with copies of the raw data files produced upon request by the central data management system software.

Table D1: Data Screening Criteria for Meteorological Measurements	
Variable Screening Criteria	**Flag data if the value:**
Wind Speed	• Is less than zero or greater than 25 m/s • Does not vary by more than 0.1 m/s for 3 consecutive hours • Does not vary by more than 0.5 m/s for 12 consecutive hours
Wind Direction	• Is less than zero or greater than 360° • Does not vary by more than 1 degree for more than 3 consecutive hours • Does not vary by more than 10 degrees for 18 consecutive hours
Temperature	• Is greater than the local record high • Is less than the local record low • Is greater than a 5°C change from the previous hour • Does not vary by more than 0.5°C for 12 consecutive hours
Temperature Difference	• Is greater than 0.8°C during the daytime • Is less than -0.8°C during the night • Is greater than 5°C • Is less than -3°C
Barometric Pressure	• Is greater than 1,060 mb (sea level) • Is less than 940 mb (sea level) • Changes more than 6 mb in three hours
Relative Humidity	• Is less than 10% • Is greater than 100% • Changes by more than 20% in 2 hours • Changes less than 2% in 12 hours • Is 100% for 12 hours or more
Solar Radiation	• Is greater than zero at night • Is greater than the maximum possible for the date and latitude
Precipitation	• Is greater than 1 inch in 1 hour • Is greater than 2 inches in 12 hours • Is greater than 2.5 inches in 24 hours

D1.2.2 Level 2 Data Validation

During "Level 2" data validation, the data file of each monitored parameter at each monitoring station is processed using the central Data Management Department software to develop an initial data report to be reviewed by the data technician for completeness and correctness. An accounting of all hours is made, with any missing data appropriately designated. Any corrections or additions to the raw "Level 1" data report are annotated in the processing data file with explanatory comments. Any hours incorporating a test, calibration or other quality control check, corrective or preventive maintenance, analyzer malfunction, power failures, etc. are removed from the data set and annotated with the appropriate AQS null data code. In all cases, any hour removed from the data set, for any reason, will be substantiated with a well-documented reason. A complete listing of null data codes used in AQS reporting can be found in Appendix 3.

Results of this review, including any data losses equal to or greater than one hourly block average, are documented and dated by the data technician in "Level 2" data files. The annotated "Level 2" data reports contain any corrections required. The data technician then enters the corrections indicated in the electronic data file. When all corrections are complete, the data are designated as "Level 2 - Final" validated data, and are archived for subsequent final data validation review.

D1.2.3 Level 3 Data Validation

"Level 3" data validation review is performed by senior project personnel other than the data processing technician. During the Level 3 data validation process, data losses due to test or maintenance activity or instrument malfunction are corroborated against documentation entered by the station field operator in the station DAS log record. The field log record identifying data affected by these activities and events are inter-compared with corresponding status flags entered automatically by the data logger or manually by the operator in the digital data record.

The results of monitor QA/QC performance checks are evaluated with respect to their conformance with relevant accuracy criteria. Standard methodologies are used for making these assessments.

Reports documenting unacceptable operating conditions or non-conformance/corrective action (NC/CA) events that may have adversely impacted data quality are also reviewed. If discrepancies or questionable data values are identified during the validation process, the entire data record is reviewed (including all annotated corrections on preliminary data printouts). Consultations with monitoring project personnel are made as necessary to obtain additional information relevant to questionable data. The objective of the validation review in these instances will be to establish a clear and defensible basis for retaining, correcting, or rejecting the data in question in accordance with published regulatory guidelines and established scientific principles.

Any additional corrections or revisions made to the data report file during the data validation review are documented, dated and signed by the validation reviewer. The corrections are then entered into the electronic data file and re-processed. A separate file containing the corrections will be checked for accuracy against the documented corrections. When all corrections are complete and checked, a final data file will be produced.

All copies of the annotated and dated data files generated during the data review and validation process are archived, as are associated field documentation, as discussed below.

D1.3 Data Reduction

Data processing and analysis will be performed using Microsoft Excel, Lakes Environmental WRPlot, and other basic computer programs. All computers used in this effort will be Windows 7 or newer operating system PCs. Data will be kept in ASCII files, readily available via e-mail to anyone requiring the data.

Under rare circumstances, data may have a known quantifiable bias. They will be corrected only if all of the following conditions are met:

- The bias has a single identifiable cause.
- The bias has a clearly defined beginning and ending time.
- The data in question meets project data validation criteria.

Any data corrections will be thoroughly described and documented in the appropriate data report.

D1.4 Data Reporting

All data handling procedures and data validation techniques will meet the relevant criteria and guidelines contained in 40CFR Part 50 for National Ambient Air Quality Standards (NAAQS) and 40CFR Part 58 Appendix A for reporting of air quality monitoring data. Archival of the data will be made by Enviroplan Consulting for a maximum of five years, at which time final disposition will be determined in consultation with Ameren. Throughout the monitoring project, all data will be considered proprietary to Ameren and will not be released to any third party without prior written authorization.

D1.4.1 Monthly Data Reports

Enviroplan Consulting will submit monthly and quarterly reports of the air monitoring data collected during the most recent, previous reporting period to Ameren. The hourly-averaged, validated data will be submitted to Ameren within 35 days following the end of each monthly reporting period.

Each monthly data report will include a missing data report that lists all missing data by parameter, the hours affected and an explanation of the reason why the data are reported as missing or invalid. Invalid data are not included in any of the summary statistics.

The information reported for each monitoring station will include:

- Sequential, hourly listings (hard copy, tabular form and in U.S. EPA AQS format on a data CD) of validated hourly gaseous and particulate pollutant and meteorological data (hard copy, tabular form and on a data CD in U.S. EPA AQS format);

- Concentration summaries for all measured pollutants, including year-to-date, highest and second-highest hourly block averages;

- Three-hour rolling averages of SO_2 data, including highest and second-highest values;

- Daily maximum hourly average of SO2 data;

- The maximum 5-minute SO2 concentration recorded for each hour;

- Meteorological hourly-averaged data listings on a monthly, quarterly, and annual basis including: average, maximum and minimum wind speeds, and joint frequency distributions of wind speed and wind direction (tabular and as wind roses);

- Comparison of measured pollutant concentrations with applicable National Ambient Air Quality Standards in units consistent with those criteria. Exceedances of the respective standards, if any, will be identified and discussed in a letter report within one business day of occurrence.

D1.4.2 <u>Quarterly Data Reports</u>

A quarterly quality assurance data report will be submitted to Ameren and MDNR APCP within 60 days following the end of each quarterly reporting period. Each quarterly data report will be submitted both as a bound hard copy and as an electronic file on CD in PDF format. The data listings will be reported in U.S. EPA AQS format on hardcopy and on the CD.

Each quarterly data report will include a missing data report that lists all missing data by parameter, the hours affected and an explanation of the reason why the data are reported as missing or invalid. Invalid data are not included in any of the summary statistics.

The content of each quarterly data report will include tabular data averages for each month (as described for the monthly data reports above as well as:

- Relevant calibration, precision, bias, and accuracy data and statistics;
- Data recovery rates and explanations of missing data periods; and
- Results from independent performance and systems audits.

The results of monitor performance checks are presented in an appendix to the monitoring data report. They are presented in tabular form and discussed with respect to conformance with applicable precision, bias, and accuracy objectives along with the conventions used for calculating these parameters. Monthly and quarterly data recovery rates and explanations of missing data periods will also be summarized. Finally, the quarterly QA data report will contain copies of the various quality assurance check forms completed during the current reporting period (i.e., calibration data, Level 1 zero/span and one-point quality control checks and independent performance and systems audits).

D1.5 Data Storage

All data handling procedures and data validation techniques will meet the relevant criteria and guidelines contained in 40CFR Part 50 for National Ambient Air Quality Standards (NAAQS) and 40CFR Part 58 Appendix A for reporting of air quality monitoring data. Archival of the data will be made by Enviroplan Consulting for a maximum of five years, at which time final disposition will be determined in consultation with Ameren. Throughout the monitoring project, all data will be considered proprietary to Ameren and will not be released to any third party without prior authorization.

Table D2: Data Review List for the Monitoring Project

Type of Data Generated	Method for Acceptance	How is Extraneous Data Identified?	Review Frequency	Person Responsible for Data Review	Project Specific Calculations
Raw Data	Data Review	Method Specific Data Validation Tables	Daily	Project and data manager	n/a
Daily Zero/Span Checks	Data Review	Method Specific Data Validation Tables	Daily	Project and data manager	n/a
Analyzer One-Point Quality Control Checks	Data Review	Method Specific Data Validation Tables	Biweekly	Project and data manager	Analyzer precision and bias statistics
Monthly Data Report	Enviroplan Data Manager	Method Specific Data Validation Tables	Monthly	Project and data manager	Monthly data capture statistics
Quarterly Data Summary	Enviroplan Data Manager	Method Specific Data Validation Tables	Quarterly	Project and data manager	Quarterly data capture statistics

D2. VALIDATION AND VERIFICATION METHODS

This section presents an outline of the procedures used to reduce the meteorological measurement data. These procedures are handled completely independent of initial data collection. The data manager and the data reduction staff are responsible for reduction of the data.

On a monthly basis, all documentation is shipped to Enviroplan Consulting's Data Management Department in Wayne NJ. The digital data (which are automatically polled each day) are reviewed for validity and reasonableness via comparison against the electronic strip charts generated from the one minute averaged data and associated documentation. Any hours incorporating a test, calibration or other quality control check, corrective or preventive maintenance, analyzer malfunction, power failures, etc. are removed from the data set and annotated with the appropriate AQS null data code. In all cases, any hour removed from the data set, for any reason, will be substantiated with a well-documented reason. A complete listing of null data codes used in AQS reporting can be found in Appendix 3. For more data reduction procedures, reference Section D1 of this document.

D2.1 Precision and Bias for Pollutant Analyzers

Precision is a measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation. Bias is the systematic or persistent distortion of a measurement process which causes errors in one direction. A one-point quality control check of each continuous gaseous pollutant analyzers will be performed at a minimum frequency of once every two weeks, the results of which will be used to assess the precision and bias of the measurement. This one-point quality control check will be conducted by challenging the SO_2 analyzers with a known test gas concentration between 0.010 and 0.100 ppm. Each one-point quality control check will be performed while each analyzer is operated in its normal sampling mode with the test gas passing through all filter and components used during normal sampling and as much of the sampling inlet system as practical. If the one-point quality control check is conducted in conjunction with zero/span adjustments, it will be performed prior to any such adjustments.

D2.2 Accuracy

Accuracy is a statistical measurement of correctness and is defined as the degree of agreement with a specific "true" value. Accuracy includes components of random error (variability due to imprecision) and systematic error (bias), and, therefore, reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ by more than the quality assurance objective from the true value or known concentration of a standard. For this monitoring program, accuracy will be assessed through analysis of independent audit standards.

D2.2.1 <u>Accuracy for Pollutant Analyzers</u>

Each continuous gaseous pollutant analyzer will be audited at a minimum frequency of once per calendar quarter when routine sampling is occurring. The independent audit consists of challenging the analyzers with a zero test gas and at least one upscale audit gas of known concentration within each of the following ranges:

Table D3: Continuous Gas Analyzer Audit Concentration Ranges	
Audit Point	**SO_2 Concentration Range (ppm)**
0	0.000
1	0.0500 – 0.0999
2	0.1500 – 0.2599
3	0.2600 – 0.7999

During each audit, each analyzer will be operated in the normal sampling mode, with the audit test gas passing through all filters and components used during normal sampling operations and as much of the sampling system inlet line as practical. Audit results will be documented on a standard audit report form for continuous gaseous pollutant analyzers.

The personnel, standards, and equipment used to perform the audit will be completely independent of those used for normal network operation. Requests by qualified outside parties, such as the MDNR APCP, to conduct an audit of the monitors will be accommodated provided adequate advance notice (~ 2 weeks) is provided.

D2.2.2 <u>Accuracy for Meteorological Monitors</u>

For continuously-measured meteorological parameters, data accuracy assessments will be expressed as a given monitoring system's deviation (in terms of percent difference) from one or more known audit challenge inputs. Performance audits will be conducted on the meteorological monitoring systems at semi-annual intervals. Personnel, standards, and equipment used will be completely independent of those used for normal operations.

D2.3 Data Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Completeness is determined after the data validation process is complete and after data precision, bias, and accuracy are calculated and evaluated against the data quality objectives. Lost data due to calibrations or other quality assurance procedures is considered missing data. The minimum objective for gaseous pollutant analyzer data completeness is 80 percent per quarter. The minimum objective for meteorological data completeness is 90 percent or greater on a quarterly basis. The 90 percent requirement applies on a quarterly basis such that 4 consecutive quarters with 90 percent recovery are required for an acceptable one-year data base. Completeness will be calculated on a monthly, quarterly and annual basis.

D2.4 Data Representativeness

Measurement data representativeness is a qualitative term to describe how well a given sample or collection of samples agrees with the entire population. Measurement data representativeness is achieved by collecting samples using standard techniques, with careful consideration given to natural sample variability arising from such factors as temporal or ambient conditions and matrix heterogeneity, as well as from artificial influences such as contamination or sample handling artifacts. Collection of representative samples is achieved by proper sampling strategy, as described in Section B.

D2.5 Data Comparability

Comparability of measurement data is achieved by:

- Using standard analytical methods and appropriate calibration techniques;
- Maintaining the performance of each measurement system in a state of statistical control through the analysis of quality control samples;
- Adhering to method specification limits for calibration, precision, and bias; and
- Reporting the data in standard units of measure.

D3. RECONCILIATION WITH USER REQUIREMENTS

The objective of the ambient air monitoring program is to better assess ambient air concentrations of SO_2 with respect to the 1-hour SO_2 NAAQS and provide high-quality meteorological data suitable for use in regulatory-approved modeling studies of emission impact studies of the environs for the Labadie Energy Center. The duration of the monitoring program is anticipated to be three years, however, this period will be re-evaluated on an annual basis. The monitoring program will be conducted in accordance with relevant MDNR requirements and guidance pertaining to air quality and meteorological monitoring

D3.1 Data Calculations

D3.1.1 Pollutant Analyzer Precision and Bias

A one-point quality control (QC) check of each continuous gaseous pollutant analyzers will be performed at a minimum frequency of once every two weeks. This check will be automatically initiated by the digital acquisition system. The one-point QC check will be conducted by challenging the SO_2 analyzers with a known test gas concentration between 0.010 and 0.100 ppm. Each one-point QC check will be performed while each analyzer is operated in its normal sampling mode with the one-point quality control test gas passing through all filter and components used during normal sampling and as much of the sampling inlet system as practical. If the one-point QC check is conducted in conjunction with zero/span adjustments, it will be performed prior to any such adjustments. At the end of each sampling quarter, data obtained from the one-point QC check will be used in calculations for data quality assessments of precision and bias for each analyzer.

Percent Difference. All measurement quality checks start with a comparison of a known concentration to the concentration measured by the analyzer and use percent difference as the comparison statistic as described in Equation 1 of this section. For each single point QC check, calculate the percent difference, d_i, as follows:

$$d_i = \frac{Y_i - X_i}{X_i} x100$$

Equation 1

Where:

Yi = analyzer's indicated concentration from the i-th one-point QC check
Xi = known concentration of the test gas used for the i-th one-point QC check

Precision Estimate. The precision estimate is used to assess the one-point QC checks for each SO2 analyzer. The precision estimator is the coefficient of variation upper bound and is calculated using Equation 2 of this section

$$CV = \sqrt{\frac{n \times \sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2}{n(n-1)}} \times \sqrt{\frac{n-1}{X_{0.1,n-1}^2}} \qquad \textbf{Equation 2}$$

where, $X^2_{0.1,n-1}$ is the 10th percentile of a chi-squared distribution with n–1 degrees of freedom.

Bias Estimate. The bias estimate is calculated using the one-point QC checks for each SO2 analyzer. The bias estimator is an upper bound on the mean absolute value of the percent differences and is calculated using Equation 3 below:

$$|AB| = AB + t_{0.95,n-1} \times \frac{AS}{\sqrt{n}} \qquad \textbf{Equation 3}$$

where, n is the number of single point checks being aggregated; $t_{0.95,n-1}$ is the 95th quantile of a t-distribution with n–1 degrees of freedom; the quantity AB is the mean of the absolute values of the di's and is calculated using Equation 4 of this section:

$$AB = \frac{1}{n} \times \sum_{i=1}^{n} |d_i| \qquad \textbf{Equation 4}$$

and the quantity AS is the standard deviation of the absolute value of the di's and is calculated using Equation 5 of this section:

$$AS = \sqrt{\frac{n \times \sum_{i=1}^{n} |d_i|^2 - \left(\sum_{i=1}^{n} |d_i|\right)^2}{n(n-1)}} \qquad \textbf{Equation 5}$$

Assigning a sign (positive/negative) to the bias estimate. A sign (positive/negative) is assigned to the bias estimate. Since the bias statistic as calculated in Equation 3 of this section uses absolute values, it does not have a tendency (negative or positive bias) associated with it. A sign will be designated by rank ordering the percent differences of the QC check samples from a given site for a particular assessment interval.

The 25th and 75th percentiles of the percent differences for each site are calculated. The absolute bias upper bound should be flagged as positive if both percentiles are positive and negative if both percentiles are negative. The absolute bias upper bound would not be flagged if the 25th and 75th percentiles are of different signs.

Validation of Bias Using the One-Point QC Checks. The annual performance evaluations for each SO_2 analyzer are used to verify the results obtained from the one-point QC checks and to validate those results across a range of concentration levels. To quantify this annually at the site level, probability limits will be calculated from the one-point QC checks using Equations 6 and 7 of this section:

$$Upper\ Probability\ Limit = m + 1.96\ \times S$$ **Equation 6**

$$Lower\ Probability\ Limit = m - 1.96\ \times S$$ **Equation 7**

where, *m* is the mean (Equation 8 of this section):

$$m = \frac{1}{k} \times \sum_{i=1}^{k} d_i$$ **Equation 8**

where, *k* is the total number of one point QC checks for the interval being evaluated and *S* is the standard deviation of the percent differences (Equation 9 of this section) as follows:

$$S = \sqrt{\frac{k \times \sum_{i=1}^{k} d_i^2 - \left(\sum_{i=1}^{k} d_i\right)^2}{k(k-1)}}$$ **Equation 9**

D3.1.2 <u>Pollutant Analyzer Accuracy</u>

The percent difference (d_i) for each analyzer audit point check concentration response will be calculated and reported using Equation 1 where Y_i is the analyzer's indicated concentration from the i-th audit check and X_i is the known concentration of the audit gas used for the i-th audit check.

Precision, bias, and accuracy data will be submitted to the Ameren and MDNR APCP each quarter in both hard copy and in electronic format, e.g., AQS format.

D3.1.3 <u>Data Completeness</u>

The minimum objective for pollutant analyzer data completeness is 80 percent per quarter. The minimum objective for meteorological data completeness is 90 percent or greater on a quarterly basis. The 90 percent requirement applies on a quarterly basis such that 4 consecutive quarters with 90 percent recovery are required for an acceptable one-year data base. Completeness will be calculated on a monthly, quarterly and annual basis. Data completeness for the meteorological methods are calculated assuming a minimum of 90 percent valid hourly average data to calculate quarterly average data completeness and a minimum of 90 percent quarterly data completeness for four consecutive quarters. Quarterly data completeness (DC_i) will be determined using the following equation:

$$DC_i = \frac{h_v}{h_i} \times 100$$ **Equation 10**

Where:

h_v = number of hours of valid data actually collected
h_i = number of possible valid hours of data collection during the monitoring period

D3.1.4 <u>Scalar-Averaged Values for Horizontal Wind Speed</u>

The scalar-averaged values for horizontal wind speed ($\bar{u}$) are computed by the data logger as the average of the measured raw horizontal wind speed data for the averaging interval. The computation for scalar mean wind speed is detailed in Section 6.2.1 of the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005). The scalar-averaged horizontal wind speed is determined using Equation 11.

Equation 11

$$\bar{u} = \frac{1}{N}\sum_{1}^{N} u_i$$

D3.1.5 <u>Scalar-Averaged Values for Horizontal Wind Direction</u>

Since the advent of modern data collection systems, questions about the validity of the original EPA scalar averaging calculation of the azimuth angle of the horizontal wind as measured clockwise from north (horizontal wind direction) have been raised which is discussed detailed in Section 2.8 of the *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. VI: Meteorological Measurements, Version 2.0 - Final* (EPA-454/B-08-002). The EPA recommends that a unit vector algorithm, which is not weighted for wind speed, be used for calculating scalar wind direction. The scalar-averaged horizontal wind direction ($\bar{\theta}$) values will be calculated using the unit vector averaging algorithm as detailed in Section 6.2.1 of the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005).

Equation 12a

$$\bar{\theta}_{UV} = ArcTan\left(\frac{V_x}{V_y}\right) + FLOW$$

Where

Equation 12b

$$V_x = -\frac{1}{N}\sum u_i \, Sin \, \theta_i$$

Equation 12c

$$V_y = -\frac{1}{N}\sum u_i \, Cos \, \theta_i$$

Equation 12d

FLOW = +180; for *ArcTan* (V_x / V_y) < 180

FLOW = -180; for *ArcTan* (V_x / V_y) > 180

D3.1.6 Standard Deviation of Scalar Wind Direction (Using the Yamartino Method)

The standard deviation of the scalar horizontal wind direction (σ_θ) as described in Section D3.1.5 above is calculated by the data logger using the Yamartino method (Equations 13a & 13b). The Yamartino method is detailed in Section 6.2 of the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005). The hourly averaged standard deviation of scalar wind direction values will be calculated based on two averaging methodologies as input variables may differ based upon the dispersion model used. The data logger is programmed with a scan rate of once per second resulting in 3600 scans over an hourly averaging period. The first methodology calculates the hourly average standard deviation using all 3600 samples obtained during the hour. The second methodology calculates the hourly average standard deviation based on an average of four 15-minute values per hour to minimize the effects of wind meander associated with light wind speed conditions (Equation 13c).

$$\sigma_\theta = \arcsin(\epsilon)\,[1. + 0.1547\epsilon^3]$$ **Equation 13a**

where

$$\epsilon = \sqrt{1 - \left[\frac{1}{N}\sum_{i=1}^{N} sin\theta_i\right]^2 + \left[\frac{1}{N}\sum_{i=1}^{N} cos\theta_i\right]^2}$$ **Equation 13b**

$$\sigma_\theta(1 - hr) = \sqrt{\left[\left(\sigma_{\theta_1}\right)^2 + \left(\sigma_{\theta_2}\right)^2 + \left(\sigma_{\theta_3}\right)^2 + \left(\sigma_{\theta_4}\right)^2\right]/4}$$ **Equation 13c**

D3.1.7 Resultant Vector-Averaged Horizontal Wind Speed and Wind Direction

Resultant vector mean wind speed ($\overline{U}_{RV}$) and wind direction ($\bar{\theta}_{RV}$) will be calculated by the data logger using the sequence of N observations of θ_i and u_i, and the mean east-west, V_e, and north-south, V_n, components of wind speed and wind direction. The resultant-vector mean wind speed and wind direction are determined using Equations 14a, 14b, 14c, 14d, and 14e.

Equation 14a

$$\overline{U}_{RV} = \sqrt{(V_e^2 + V_n^2)}$$

Equation 14b

$$\bar{\theta}_{RV} = ArcTan\left(\frac{V_e}{V_n}\right) + FLOW$$

Where

Equation 14c

$$V_e = -\frac{1}{N}\sum u_i \, Sin \, \theta_i$$

Equation 14d

$$V_n = -\frac{1}{N}\sum u_i \, Cos \, \theta_i$$

Equation 14e

FLOW = +180; for $ArcTan\ (V_e / V_n) < 180$
FLOW = -180; for $ArcTan\ (V_e / V_n) > 180$

D3.1.8 <u>Standard Deviation of Resultant Vector-Averaged Horizontal Wind Direction</u>

The standard deviation of the resultant vector mean wind direction will be calculated using a wind speed weighted algorithm. The hourly averaged standard deviation of resultant vector wind direction values ($\bar{\sigma}_{\theta RV}$) will be calculated (Equation 15a)based on two averaging methodologies as input variables may differ based upon the dispersion model used. The data logger is programmed with a scan rate of once per second resulting in 3600 scans over an hourly averaging period. The first methodology calculates the hourly average standard deviation using all 3600 samples obtained during the hour. The second methodology calculates the hourly average standard deviation based on an average of four 15-minute values per hour to minimize the effects of wind meander associated with light wind speed conditions (Equation 15b).

$$\bar{\sigma}_{\theta RV} = \sqrt{81(1 - \bar{U}/S)}$$ **Equation 15a**

$$\sigma_{\theta RV}(1 - hr) = \sqrt{\left[\left(\sigma_{\theta RV_1}\right)^2 + \left(\sigma_{\theta RV_2}\right)^2 + \left(\sigma_{\theta RV_3}\right)^2 + \left(\sigma_{\theta RV_4}\right)^2\right]/4}$$ **Equation 15b**

D3.1.9 <u>Scalar-Averaged Vertical Wind Speed</u>

The scalar-averaged values for vertical wind speed ($\bar{W}$) are computed by the data logger as the average of the measured raw vertical wind speed data for the averaging interval. The computation for scalar mean vertical wind speed is detailed in Section 6.2.1 of the *Meteorological Monitoring*

Guidance for Regulatory Modeling Applications (EPA-454/R-99-005). The scalar-averaged horizontal wind speed is determined using Equation 16.

Equation 16

$$\bar{W} = \frac{1}{N}\sum_{1}^{N} W_i$$

D3.1.10 <u>Standard Deviation of Vertical Component of Wind Speed</u>

The standard deviation of vertical component of wind speed (σ_W) is a precursor for the standard deviation of the vertical wind direction (σ_ϕ) and is calculated using Equation 17.

Equation 17

$$\sigma_W = \sqrt{\frac{1}{N}\left[\sum_{1}^{N} W_i^2 - \frac{1}{N}\left(\sum_{1}^{N} W_i\right)^2\right]}$$

D3.1.11 <u>Temperature Difference</u>

Temperature difference (ΔTemp) is calculated by the data logger using the convention of temperature measured at the upper level minus the temperature measured at lower level. It is determined using Equation 18.

$$\Delta Temp = Temp_{Upper} - Temp_{Lower}$$ **Equation 18**